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G. WARREN DRESSER, Editor,

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☞ An asterisk (*) denotes an illustrated article

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WISHING TO MAKE THIS JOURNAL an organ of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, the publishers solicit letters from all among them who make the study of these subjects a pleasure, or a profession.

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OPPOSITION IN TRENTON, N. J.

The new gas company that has been operating in Trenton for some time, and selling gas made under the direction of Prof. Lowe, has not exploded exactly, but the "foundation of things" seems to have dropped out; and at a recent stormy meeting of the management enough stock was sold out, at 50 cents on the dollar, to place the company under the control of the old coal gas company. The Trenton *State Gazette* thus speaks of the enterprise—

THE GAS EXPERIMENT.

The experiment of starting a new and rival gas company in this city has come to a lame and impotent conclusion, for which we are sorry. It will be a discouragement to the undertaking of all similar enterprises for a good many years to come, and will help to increase the city's reputation for an old fogy adherence to established things, whether they be good or bad.

The reasons given by the directors and stockholders of the company for selling out are, however, far from being clear and satisfactory to the public. When the company was first organized it loudly professed its ability to make much better gas than by the old process, and at an absurdly low figure. It could sell far below even the cost of making gas under the old plan, and still make a good profit. The stock was a perfect bonanza, and the stockholders were to roll in riches in a very few years. The doubts and hesitations of those prudent citizens who declined to swallow all this on the bare assurance of enthusiastic but impracticable and inexperienced men, was treated with lofty contempt. Those who mildly suggested that if there was so much money in this thing it was a little singular that the capital of the country, which is generally supposed to have its eyes pretty well open, did not rush into it in all the great cities, were promptly, and with much fine scorn, set down as financial owls. There was no mistake or possible hitch anywhere. The whole process and its profits were as clear and as demonstrable as a sum in addition.

And now we are told, with a dropping of their high pretentions, and a lameness of logic that is simply amusing, that among the reasons why the company has been obliged to sell out, are :

"That the gas did not give satisfaction to the consumers, and that they (the directors), considered the process imperfect, by reason of a bad smell coming from the gas and the gumming up of the pipes and burners."

And,

"Indifference of the public, who would not take gas and stock."

To blame the public for not taking gas, which gummed up, and gave a "bad smell" instead of satisfaction, will strike most people as rather attenuated. And to further blame them for declining to invest in stock founded on that kind of gas, and which the possessors are obliged to sacrifice at a loss,. divulges a childlike confidence in the eagerness of the public to be victimized which is refreshing.

CARBONIC OXIDE IN ILLUMINATING GAS.

We give considerable space to-day to a communication from the pen of Mr. Robert Briggs, C.E., upon the analyses of Harrisburg gas, made by Prof. Morton, of the Stevens Institute, and published in our issue of Nov. 3d.

The article bears the signs of thoroughness and fairness which always characterize the writer, and while we agree with the author that the success of the various water gas projects will not depend upon the amount of hue and cry that may be raised against them, on the ground that the constituents of this gas are dangerous, and fatally poisonous if inhaled in even moderate quantities, still it must be admitted that either the vast majority of usually accepted medical and chemical authorities are all wrong, or else Mr. Briggs is in error in stating that "carbonic oxide is *not* one of the most virulent and dangerous of gas poisons."

Dollars and cents must determine the success or failure of all these processes ultimately. If they can be made to pay in any way they will probably continue to be used in spite of "poison"; and those interested will have great difficulty in being convinced of the poisonous and dangerous qualities of the gas. Doubtless, those having charge of water gas works may say that it is no worse to be "knocked over" by water gas than by coal gas; but we feel confident that the men who have suffered from the "knocking over" would hardly coincide in opinion. In fact we are informed that, in this city, within two years, some difficulty has been experienced in keeping men at work in trenches where an escape of water gas existed. This was perhaps ignorant prejudice. Some authorities, considered reliable, speak very distinctly with reference to the nature of carbonic oxide. (CO.)

Johnson's Encyclopedia, p. 774, says—"Even when largely diluted with air it acts as a narcotic poison to those who inhale it."

Roscoe's Chemistry, new edition, p. 93, says—"It acts as a strong poison, producing death when inhaled even in very small quantities. The fatal effects, often observed, of the fumes from burning charcoal, or from lime kilns, being due to the presence of this gas."

We will not quote other authorities, the number of which is legion, who coincide in this opinion; but we will simply give a few extracts from the report of M. Pelouze to the Municipal Council, of Paris, in sittings of June 24th and 28th, 1854, which may be found recorded in the London *Journal of Gas-Lighting* for Sept. 11th, 1854, vol. III., p. 530:

KIRKHAM'S GAS.

The use of this gas should also be severely forbidden, and to prove it your reporter need only cite the passage from the *proces-verbal* of your third sitting, in which is reproduced the opinion emitted before the commission by M. DUMAS, the distinguished professor of chemistry, and member of the French Institute.

"The oxide of carbon," said M. Dumas, "is a gas known from the commencement of the present century, and for many years no one thought of attributing venemous properties to it—no man of science suspected it. When, therefore, fifteen years since, it was proposed to me to employ water gas for lighting and heating, I must acknowledge I did not hesitate to advise, in my course of lectures, the making of epxeriments in this direction. M. Selligue appropriated to himself this idea, and made gas by the decomposition of water in the works at Batignolles, and rendered it luminiferous by means of oil of schist. Neither M. Selligue nor any one else then knew that this gas was poisonous, that was discovered later by M. Leblanc, in my laboratory, and we made some decisive experiments. It was proved that a mixture of 1 per cent. of oxide of carbon killed a strong dog in a minute and a half; it was a case of poisoning. With 1 per cent. of oxide of carbon, all animals died at the end of a few minutes. These experiments terrified me. Since then they have been repeated many times by different men of science. Carbonic acid must not be confounded with oxide of carbon. In the course of the experiments of which I have just spoken, I formed an artificial atmosphere with 30 per cent. of carbonic acid. A large dog, on being placed in it, almost immediately fell on his side, but recovered himself on being restored to the pure air. *Thirty per cent. of carbonic acid did not kill; but, on the contrary, 1 per cent. of oxide of carbon is mortal,* I am, therefore, satisfied that this oxide has the greatest inconveniences—above all, when applied to lighting.

"M. Selligue believed, with the most entire good faith, in the excellence and in the harmlessness of his process. He lighted a part of the town of Strasburg; one night the gas penetrated into a baker's shop, and several persons died. This was the first proof of the poisonous properties of this gas. Some time afterwards, M. Dupuis Delcourt was desirous of making a balloon ascent, and, instead of taking hydrogen gas, he was obliged, by an accident, to employ the gas of M. Selligue. The balloon was inflated; at the end of some seconds the aeronaut fell suffocated in his car. The balloon descended to the earth, and M. Dupuis Delcourt recovered his senses, but the persons who approached the balloon to give him assistance fainted and fell.

* * * * *

"It is impossible to admit that a gas producing such effects should be employed in any close apartment, in a shop, or in a theatre."

[Communicated Article.]

Water Gas.

The publication in the AMERICAN GAS-LIGHT JOURNAL, of Nov. 3d, of analyses of gas made by the Lowe process, at Harrisburg, Pa., by Prof. Henry Morton, of the Stevens Institute, brings up anew some old questions as to the chemistry and physics of water gas, and as to its suitability for general public and private use as illuminating gas.

Prof. Morton's analyses may be accepted fully as exhibiting the most favorable production of this gas as a process. From these analyses it is made evident that through the action of heat a certain volume of steam has been separated into its original elements of hydrogen and oxygen, or at least the hydrogen component has been set free, and the oxygen taken up by or absorbed chemically into such proportion of carbon (which was present as incandescent anthracite coal) as will form carbonic oxide. The hydrogen and carbonic oxide are shown by the analyses to be, say, 30 per cent. each, or, together, 60 per cent. of the gas at Harrisburg, while the remaining 40 per cent. is composed of marsh gas and petroleum vapors, which 40 per cent. may be taken as having its derivation from the benzine or petroleum, the use and distillation of a certain quantity of which is a part of the Lowe process. The Harrisburg gas, like most of the recent water gases, deriving its illuminating qualities from this source, in place of the cannel coal, rosin, oil or other substances which were used in the older processes. The analyses do not exhibit the exact proportions stated above, but the most of the variations between them and this statement are due to imperfections of production inseparable from all processes which may give rise to carbonic acid gas, and which do not in any way eliminate the original impurities of the fuel or the petroleum. A theoretically perfect water gas for illuminating purposes can be accepted to have very nearly the constituents stated above.

Let a consideration be had as to what occurs in the dissociation of water, the elimination of the hydrogen, and the formation of the carbonic oxide of this assumed volume of 60 per cent. of the gas. One pound of hydrogen is found in nine pounds of water (or of steam which is water vaporized by heat); and one pound of hydrogen in burning with eight pounds of oxygen will give out 62,000 units of heat, forming in this manner the nine pounds of water. [A unit of heat (English) being the heat of elevating the temperature of one pound of water, one degree]. *The dissociation of water to again form hydrogen and oxygen will necessarily have a cooling effect, that is, heat must be supplied from other sources, equal to* 62,000 *heat units.* In this Lowe process a certain portion of the heat is supplied at once in the vaporization of the water into steam. Suppose the condition of the steam, when it reaches the incandescent fuel or material which is to decompose it, to be equivalent to dry steam at 212°, then 966 units of heat will have been expended on each pound in vaporization from 212° [In the data which gives 62,000 heat units as coming from the combustion of one pound of hydrogen the assumption made was that the hydrogen was burned from some usual temperature, say 70°, and the products reduced to that temperature, when the latent heat of evaporation became, 1065° in place of 966°; but as in this case the products of combustion are of much higher temperature than 70°, the 99° which would follow from perfect utilization of the heat may be considered as expended in imparting hea to them. This supposition does not imply merely the addition of 99° to the temperature of the resulting gases, here the low *specific heat* of these gases causes the 99° in units of weight of water to be equivalent to 387°, which gives 600° as the temperature of the escaping gases. It may be well to remark here, that the numerous attempts to gain an increment of heat by superheated steam when making water gas, have been failures from the physical conditions. The quantity of heat wanted is enormous when the small amount of steam which is the supposed vehicle is considered. Suppose the steam to be under constant pressure and suppose that its specific heat remained the same at high temperatures, theory demands that the steam should be heated to 12,400° and at once fall to 70° when dissociation occurs. There is scarcely any practical application to be made of superheated steam]. Following the supposition that the heat of evaporaoration at 212° or 966 units is supplied as a preliminary to the gas making process, the nine pounds of water will have furnished $(9 \times 966) = 8{,}700$ units of heat, leaving 53,300 units as requisite to complete the elimination of one pound of hydrogen.

The process from this point is as follows: nine pounds of water with six pounds of carbon will, from the action of heat, yield one pound of free hydrogen together with fourteen pounds of carbonic oxide, made by the combination of eight pounds of oxygen with six pounds of carbon. The combination of each pound of carbon with the oxygen will evolve 4,400 units of heat; whence $(6 \times 4400 =) 26{,}400$ units will be eliminated from this source. This leaves $(53{,}300 - 26{,}400 =) 26{,}900$ units of heat to be supplied by contact of the gases with heated coal, or other heated bodies such as fire brick [illegible] temperature of which must be above that of dissociation even after parting with large quantities of heat. The heat to be supplied to these incandescent materials must evidently be derived by the burning of fuel other than that which furnished the carbon for the carbonic oxide. The resulting volume of these fifteen pounds of gas is 374 cubic feet at 70°, the specific gravity of the mixture of hydrogen and carbonic oxide is 0.52 (as compared with air unity) and there is 23·16 cubic feet of the gas to the pound.

The claim of the "Lowe process" is that 50 pounds of anthracite and three gallons of petroleum (benzine) will make 1000 cubic feet of illuminating gas of somewhat above standard quality on an average production. It is understood that about 4000 cubic feet is the result of each effort or "run" of the process. Reducing Prof. Morton's figures there appears to be requisite for the production of 4000 feet of the gas:

65·1 pounds of water in the form of steam.
38·8 pounds of carbon in the form of anthracite coal devoid of ash.
79·4 pounds of hydrocarbon in the form of petroleum* products of destructive distillation of benzine or petroleum.
2·7 pounds of atmospheric air.

186· pounds of gas of 0·62 density = 0·0465 lbs. per cubic foot at 70° = 4000 cubic feet in all. (In fact this gas must have had 1 to 1½ per cent. in volume of aqueous vapor, but it may be supposed that Prof. Morton neglected this in his analyses, and refers to dry gas.)

The formation of this 4000 cubic feet of gas so

* In this estimate of petroleum I take the proportion of marsh gas to olefines as that given by Prof. Morton, considering the density of the olefines to b equal to that of olefiant gas—an approximate r of course, follows.

far as the chemical changes accompanying the formation of water gas is concerned, involves the expenditure of about 163,000 units of heat. The heat demanded for the distillation of the petroleum is altogether uncertain. Some theories suppose that little or no heat is expended in such a distillation, only that the attaining of some given temperature for an instant of time releases the atoms of the hydrocarbons, so that they form new elective combinations, any of which will produce heat when burned in combination with oxygen proportionate to the quantities of carbon and hydrogen in each of them. But it is clear that a high heat must be attained and perceived in the vessels of decomposition—retorts, generators, or what not, and that these vessels are exposed to great losses of heat to the surrounding air. If 500,000 units of heat were taken as a guess for the requirement of heating a "run" of the Lowe gas, and the average yield of heat from anthracite coal of fair quality of 10,000 heat units to the pound be accepted, then 50 pounds of coal per run would be required for this purpose. The 38·8 pounds of carbon which form the *material* of gas making, may be held to result from 45 pounds of anthracite coal as above, so that 95 pounds of anthracite become the estimated quantity for a *run* of the process. The 79·4 pounds of hydrocarbon could proceed as a least quantity from 10·9 gallons of petroleum of 0·87 density. It is claimed for the Lowe process 200 pounds of anthracite and 12 gallons of petroleum will yield 4000 cubic feet of gas; the theoretic quantities based on Prof. Morton's analyses may be considered as 95 pounds of anthracite and 10·9 gallons of petroleum. The loss from the estimated best result is 105 pounds of anthracite and 1·1 gallons of petroleum each run.

Taking any of the water gas processes, including and since that of White in 1852, whether by "generator" or by "retort," as the means of exposing the water to the heat of dissociation, the result of the Lowe process at Harrisburg compares favorably both in fuel and in product. If such gas, as Prof. Morton describes, can be made as a general thing from the materials claimed by the Lowe people, without inordinate wear upon the apparatus, the success of this new water gas project is but a question of time.

The remainder of Prof. Morton's paper, referring to the character of this gas, in regard to its suitability for public use for illuminating gas, is open to grave question as to the facts and deductions, and seems to demand an answer to prevent a popular spread of such views. The issue was made, considered, and determined years ago, not only with "water gas," but with other coal gas of any kind. Undoubtedly, "the presence of even a few per cent. of [any illuminating gas as well as of] this gas in the air of a room renders it utterly unfit for breathing, and often even fatal." But carbonic oxide gas *is not* "one of the most virulent and dangerous of gas poisons," and no serious difficulty does arise from the presence of carbonic acid gas, whether resulting from the burning of carbonic oxide, or of carbon in other conditions of gaseous combination, in vitiating the air of rooms as usually constructed and occupied, where illumination, in the ordinary sense, proceeds from such burning.

As a gas, carbonic oxide, pure and simple, is but in the least degree more dangerous than ordinary coal gas. The Professor can try for himself on the lower animals, and I am convinced he will find poor "pussy" quite as quickly affected, and quite as difficult to resuscitate, and quite as little poisoned with the second as with the first; and that the *percentage* of gases present in the air necessary to produce asphyxiation in nearly equal times will not materially vary. From personal enquiry which I made a few years since at a gas works, where a water gas process continued in use for a long time, I obtained such information as to induce me to believe that no poisoning whatever followed the inhalation of carbonic oxide. It did seem to be more active in causing insensibility, in knocking a man over, as a workman said, but no real disaster, or even serious case of suffocation ever happened. Headaches, of the same intensity of discomfort as those which follow the accidental breathing of coal gas, were the worst resulting effect. Certainly any one who will breathe an atmosphere largely composed of coal gas will be suffocated unless promptly removed from the locality.

It is easy to write that "the presence of a few per cent. of gas in the air of a room renders it utterly unfit for breathing, and often even fatal," but it is well to consider what a few per cent. means. There are many persons who habitually sleep in chambers of no great size (cubic capacity) and which have no especial provision for ventilation, with a gas-light burning all night; while there are few who from some cause may not have done so frequently, or at least at times. An ordinary small bed room of the smallest size may be taken as having 100 square feet of floor (10′ × 10′ or 8′ × 12′) and to be nine feet in height, having thus 900 feet capacity. In such a sleeping room, with one or two occupants, a gas burner is often permitted to remain lighted all night. Suppose the burner to consume ordinary quality and density of coal gas, at the rate of five feet per hour; the burning of this gas would evolve in the same time 0·345 pounds of vapor of water, and 0·326 pounds of carbonic acid gas, the volume of the latter substance being 2·9 cubic feet, at a temperature of 70°.

In the absence of any specific gravity figures for the Harrisburg gas, the density of the vapors or gases designated as olefines can be taken to agree with that of olefiant gas (=0·981) when a careful computation of the data, which is otherwise ample for the exactness of this statement, gives a specific gravity of 0·62; that of ordinary coal gas, of 14 to 15 candle power, being 0·43. The same computation which gives the density finds nearly the same quantity of carbon present as in the same *weight* of ordinary coal gas; but as the volumes of these gases vary inversely with their specific gravities, that is as 0·43 to 0·62, it follows that a cubic foot of Harrisburg gas contains 44 per cent. more carbon than a cubic foot of ordinary coal gas. Here, again, the data fails; no report of the illuminating value of Harrisburg gas accompanies the analyses. If this is on an equality in illuminating power with coal gas, then 44 per cent., and not 70 per cent., as given by Prof. Morton, more of carbonic acid gas will be evolved in giving equal light in equal time.

But this discussion as to proportionate quantities of carbonic acid gas is an episode in the argument. About three cubic feet of carbonic acid gas come from the burning of ordinary coal gas, with a five foot burner, each hour. Not the slightest ill effect follows to the occupant of a sleeping or other room from this hourly supply. If it were all retained in the room, from complete absence of ventilation, it would take three hours before the supposed bedroom, of 900 cubic feet capacity, would have one per cent. of carbonic acid from this source alone. The exhalations of breath give out about 0·6 cubic foot of carbonic acid gas in an hours' time, so that in an occupied room, of 900 cubic feet capacity, entirely closed from ventilation, one per cent. of carbonic acid might accumulate in less than three hours. While with any reasonable ventilation, suited to render such a chamber habitable, the reaching of one per cent. is a simple impossibility in any length of time of probable gas burning and occupancy whatever. In reality, 7-10ths of a per cent. of carbonic acid gas has been found in crowded, long occupied, closed rooms, under conditions of external atmosphere as regards temperature and moisture peculiarly unfavorable to diffusion, or to inducement of natural ventilation, and at no other times. The ultimate product of combustion of carbon is aptly stated by one eminent chemist as "an invisible, innocuous gas," and the same may be said of the product of combustion of hydrogen. Both of these gases are excreted cutaneously from all animals and the presence of either of them in an atmosphere of habitation to the proportions of a few per cent. will be found decidedly unhealthy, rising to the point of danger by interrupting the natural secretions. Carbonic acid gas must be diffused, while aqueous vapor will not only diffuse but will condense so as to reduce the percentage present in air at temperatures far above those of comfort or of nature in the habitable part of the globe.

On the other hand it must be admitted that all illuminating gas is very dangerous when permitted to escape into a room unburned. The same course of reasoning which has been followed with regard to carbonic acid gas can be applied to unburned coal or other illuminating gases, with correction for time, in that the last gases will be supplied to a room as five feet to three feet of the first. But far less than one per cent. is dangerous. Whilst writing this article, within a single week, the newspapers give four resuscitations of persons in hotels (in different parts of the country) who had had three or four hours exposure to the effects of gas escaping from a burner in the bedchamber. The chance of any person surving who goes to sleep with an extinguished open gas burner in his closed room, and remains unawakened until morning, is not very great. What however I wish to show distinctly is that there is little choice as to whether the gas of suffocation, in such case, shall be thirty per cent. of carbonic oxide, or have the same thirty per cent. substitued by marsh gas.

For nearly thirty years the efforts to make a water gas have been repeated and persistent; success has been a *remote* accomplishment—the place where it has been reached has always been a long way off; and, by a curious fatality, just at the time when at any place complete success has been reached the processes have been superseded or suspended. The Lowe process differs from other "generator" processes in the intermittent action, so that the resulting gas is nearly free from nitrogen derived from the air of combustion which supplies the heat to effect the dissociation of water. As to the final economical or practical result of this process I express no opinion, it remains to those who are interested in it to develop it if they can; but it is clearly proper that it should have a fair chance on its merits, and that it should not be condemned upon the hypothesis that it is especially dangerous above ordinary coal gas, or that it is too dangerous to use.

There is, however, one other question of great public interest, in connection with this and other novel gas processes, which are being offered to form the bases of rival gas companies in our cities. Is it really good policy for our legislators to grant, or for our capitalists to encourage, or a sound political economy for our writers to advocate, the wholesale destruction of property which

is involved in the formation of a new gas company, to occupy the best portion of a city already provided with means for supplying any demand for gas-lighting? The greatest saving imaginable in the cost of gas making is but a small item in the profits of a gas company, when estimated with regard to the income from that portion of the territory covered by the companys' distribution, which brings a really remunerative return on the prime investment. Gas at any cost of practical gas making, high or low in cost, can be sold at a great reduction from the uniform price, at a profit, to consumers resident within a certain one-sixth or one-eighth of the area of any of our cities. * * *

This train of argument would open a discussion much longer than should be based on a consideration of analyses of Harrisburg water gas.—That man may be a great benefactor to his species "who makes two blades of grass grow where one grew before"; but it may remain a mooted point whether the inventor who has succeeded in getting two capitals, and two supplies for one demand, has really achieved what is conducive to the public good.

ROBT. BRIGGS, C. E.

Philadelphia, Dec. 5th, 1877,
220 *South 4th Street.*

Report of Bureau of Lamps and Gas for Quarter Ending Sept. 30, 1877.

DEPARTMENT OF PUBLIC WORKS,
BUREAU OF LAMPS AND GAS,
NEW YORK, October 5, 1877,

Hon. ALLAN CAMPBELL, Com'r of Public Works:

Sir: In accordance with the provisions of section 27, chap. 335, of the laws of 1873 (the City Charter), I submit the following report of the transactions of "The Bureau of Lamps and Gas" for the three months ending September 30, 1877:

In Exhibit "A" will be found an abstract of all vouchers certified by me during the quarter. Exhibit "B" is a statement showing the various amounts expended for gas to the several public markets, offices, etc., and for fitting up, repairing. and lighting the public lamps, etc. Exhibit "C" is a summary of the appropriation for "Lamps and Gas," for 1877, showing an expenditure during the quarter of one hundred and forty-nine thousand six hundred and thirty dollars and eighty-six cents ($149,630.86), and, for the nine months, of four hundred and forty-two thousand seven hundred and fifty-eight dollars seventy-seven cents ($442,758.77), with liabilities for lighting the public lamps, month of September, amounting to forty-six thousand and seven dollars and twenty four cents ($46,007.24); also transfers by the "Board of Apportionment," to various other appropriations, of eighty-three thousand nine hundred and four dollars and five cents ($83,904.05), leaving an available balance for the ensuing three months of one hundred and fifty-two thousand three hundred and twenty-nine dollars and ninety-four cents ($152,329.94). Exhibit "D" is a summary of the "Lamp Account," and shows the number of new lamps lighted, old lamps relighted, and lamps discontinued by each gas company during the quarter, and the total number of lamps burning September 30, 1877, under the supervision of this department, to be twenty thousand seven hundred and eighty-seven, there being an increase during the quarter of one hundred and eighty-one; this includes the new lamps erected at Riverdale, those on the public piers, and on portions of new streets in the upper sections of the city. In Exhibit "E" will be found a statement showing the illuminating power of the gas supplied by the New York, Manhattan, and New York Mutual Gas-Light Companies. It will be seen by this statement that the gas furnished by each company has exceeded the limit required by their contracts, which is sixteen candles. The figures therein shown are taken from the weekly reports of the "Gas Examiner," and give the lowest, highest, and average illuminating power during each week, the examinations being made daily.

During the past month the painting of all the lamp posts and lanterns has been completed by the several gas companies in accordance with their contracts. This work will be quite advantageous to the city, inasmuch as the iron posts and the tin work of the lanterns will be preserved by the paint, while all the public lamps present a neat and cleanly appearance, and an increased amount of light is obtained by the whiteness of the inside of the lantern. This has all been effected with but trifling expense to the city, while, in former years it has been a source of extravagant and useless waste of the public moneys, inasmuch as what little work was done, was effected in a very inferior and unworkmanlike manner. I deem it due to the New York and Manhattan companies to publicly state that in painting the lamps in their districts they have done more than the contracts required, as all the large ornamental lamp-posts with clusters of lamps were painted in a very neat and ornamental manner, instead of the plain color required for the ordinary posts.

On the 10th of July a contract for erecting and lighting, not to exceed seventy-five lamps at Riverdale, in the Twenty-fourth Ward, was awarded by the "Gas Commission" to the Yonkers Gas-Light Company, at the rate of fifteen dollars and forty-five cents for lighting each lamp for the five and one half months ending December 31st next. On July 21st, the contract was duly executed, and on the 27th seventy one lamps had been erected and lighted, and as a consequence, this beautiful suburb now presents after nightfall a safer and more cheerful appearance. In locating these lamps I did not follow the rule adopted in the city proper, that is to say, of placing the lamps at regular distances of about one hundred feet apart, but rather selected locations, irrespective of distance, where the light would show to the best advantage. This was necessary in consequence of the limited number of lamps allotted, and my desire to benefit as far as possible all sections of the place. The length of the streets on which the lamps are placed is two and three quarter miles, the shortest distance between lamps is 115 feet, and the longest 420 feet, while the average distance is about 200 feet. There is left on Riverdale avenue, south of Mount St. Vincent, a vacant space of about 4,000 feet, on which, I think, about nineteen lamps should be erected, as this appears to be the main thoroughfare to Yonkers, the lamps to be located 200 feet apart.

On August 20, a communication was received from the Department of Docks, in answer to your letter of June 23, stating that said department would co-operate in the erection of lamp-posts for lighting certain designated piers on the North and East rivers. I accordingly entered at once upon the prosecution of the work, and during the month of September the piers at foot of Harrison street, Franklin street, West Tenth street, Twenty-second street, and Twenty-fourth street, North river; and Thirty-third, Twenty-third and Grand streets, and Pier 24 East river, were properly lighted, as also several bulkheads on both rivers. It is found that the work, as far as progressed, has been of much benefit to all persons having occasion to visit the water-front after nightfall, and the improvement has received general approbation. There are still left many dark and somewhat dangerous spots on both rivers, where the presence of gas-lamps will be of service towards the prevention of crime and perhaps the saving of human life, and I have consequently made a note of these places and arranged for the erection of lamps. In lighting the above mentioned piers I have used, where practicable, an iron lamp-post of the ordinary pattern, but with a flange four inches in width on the bottom of the base, and this is secured to the deck by four five-eighth bolts; where these posts would not be deemed safe, in consequence of the danger of their being broken by the concussion of heavily laden vehicles, wooden pile buts have been used of twelve inch diameter and four feet in height above the deck, and on this is mounted an appropriate and somewhat ornamental iron column, about five feet six inches in height, and containing the lantern; an inch groove cut lengthwise of the pile contains the stand-pipe for the gas, vulcanized rubber-coated pipe was exclusively used, as the ordinary wrought-iron pipe would be too liable to corrosion in consequence of its exposure to the moisture of the salt water.

Mrs. John Jacob Astor, having requested and obtained your permission to erect, at her own expense, several "drinking fountains" in various localities throughout the city for the benefit of the thirsty wayfarer, I deem it proper to place upon public record those which, in part, come under the care of this Bureau, inasmuch as they are fountains and lamps combined. One of these is located at the intersection of Astor place with Clinton place, opposite the Mercantile Library building, and the other on Thirty second street, between Broadway and Sixth avenue, opposite the Union Dime Savings Bank, two locations previously lighted by the ordinary street lamp. The new lamps are of a neat and ornamental character, and I think that the lady is entitled to credit for her thoughtful and generous regard for the comfort of the people.

In report of June 30, I stated that rooms had been procured in the building known as "Odd Fellows' Hall," situated on the southeasterly corner of Grand and Centre streets, and that suitable apparatus was then being fitted up and adjusted for the purpose of testing the gas supplied by the several gas companies doing business in the lower section of the city, and also the burners furnished to the public street lamps; this expenditure being incurred in compliance with a resolution of the Common Council ordering the same to be done, The necessity of having such apparatus in this city has been often seen in consequence of frequent criticisms by the public press and complaints from the people in regard to the quality of the gas. It was also a necessity because our contracts require that the gas supplied to the public lamps shall be of an illuminating power of not less than sixteen candles when tested by a photometer at a distance of not less than one mile from the place of manufacture, and, as regards its purity, shall be free, within limits, from all ingredients injurious to health or capable of deteriorating its illuminating power. In the absence, however, of proper apparatus, the city authorities have labored under the disadvantage of having no means of ascertaining the quality of the gas or how free it might be from noxious compounds. Since the first discovery of gas as an artificial light frequent improvements have been made in its manufacture for the purpose of increasing its illuminating power, freeing it from impurities, and economizing its production; and it has become a necessity to all well regulated communities. In fact its whole history furnishes many examples of the progress with which domestic illumination has advanced. At first the only lights in the public highways were those used by the cautious citizen who deemed it prudent to make his nocturnal visit under the protection of a flambeau or a lantern, or the lamp hanging from the house front. In modern times, however, a wonderful change has been effected by the use of gas in the whole system of artificial illumination, and it has also produced an equally important change in the domestic concerns of the people. It has economized industry, developed the arts, protected property, diminished crime and operated in various ways as a medium of wealth, prosperity, and social improvement. Notwithstanding all this it has been a frequent source of discussion between the gas companies and the public in all places where it is used.

To solve the question as to what constitutes a proper quality of gas for this city, rooms have been procured and fitted up, as before stated; and as perhaps but comparatively few of our citizens have any conception of the method by which the tests are made, it may not be out of place to give a description of the

means employed for the purpose; and in order for a proper understanding of the apparatus and its workings, a reference is here made to the science of

PHOTOMETRY.

This is the art whereby the relative illuminating power of artificial light is determined. Practical photometry depends, firstly, on the sensibility of the visual organs and on the mental power to judge, under favorable conditions, respecting the equal illumination of any object; and secondly, on the law that the degree to which an object is illuminated is inversely proportionate to the square of the distance of the object from the source of light.

Many photometers have been invented, but those only which are based on Bunsen's method have been generally employed. Bunsen invented a screen or disc of paper greased over part of its surface, so as to render it unequally translucent. This disc was supported or held in an upright position, and the lights to be compared were placed one on each side of the disc, in such manner that a straight line, if extended from light to light, would pass through the centre of the disc at right angles to its surface, and also through each flame midway between its apex and base. The weaker light was then moved towards the disc until the disc became equally illuminated on each side, and, as a consequence, the inequality in the translucency of its parts became inivsible, or nearly so. The distance from the disc to the centre of each light was then measured and squared, and the quotient which resulted from the division of one of the squares by the other gave the relative illuminating power of the flame. Improvements have been made from time to time on Bunsen's method for the purpose of rendering the comparison of artificial light as facile and exact an operation as possible. Probably the most obvious of these consist in the employment of a graduated bar of specific length, the fixing of the lights at its ends, and the attachment of the disc to a slide resting upon and free to move along the bar between the lights. The graduations on the bar indicate, on inspection, the value of the stronger light in multiples of the weaker, thereby saving trouble and also preventing the possibility of errors, which might, in the absence of such graduations, arise from inaccuracy in measurement and in calculations. The fixing of the lights conduces to regularity of combustion, which is liable to be disturbed by motion. Other and possibly not less important improvements have been introduced by William W. Goodwin, of Philadelphia, the value of which will be understood from the description hereinafter given of the apparatus procured from him for the use of the Department of Public Works of this city.

Photometry is practised for several purposes, viz.: to ascertain the relative value of the various substances used in artificial illumination and the most advantageous method of burning them; as a means of selecting burners which are best adapted for the perfect combustion of illuminating gases, and as an aid to the improvement of burners themselves, etc. But the purpose for which it is most extensively practised is to discover whether the gas supplied by gas companies possesses such an illuminating value as the public have a right to expect, and the requisite candle-power usually fixed in the contracts between the companies and municipalities; and it is for this purpose that a complete laboratory and photometry-room have been fitted up in "Odd Fellows Hall," before mentioned. At this place daily tests are made of the different gases furnished to the lower section of the city. These tests cover those for photometry, impurities (such as sulphur, ammonia, carbonic acid, carbonic oxide, bisulphide of carbon), and for density and specific gravity. In the photometric-room has been placed a 60-inch bar photometer, constructed upon the Bunsen principle before referred to, with various improvements suggested by Dr. Letheby and Mr. Sugg (of England), with the more recent ones of Mr. Goodwin, of Philadelphia. These consist of a delicate candle-balance placed so that the candle can be weighed "in situ," thus dispensing with any necessity for handling the candle, always more or less a source of error; also an electro-magnetic attachment for instantaneously stopping clock and meter and extinguishing gas and candle when normal quantity of gas or sperm has been consumed, on expiration of time for which the instrument may be set. In addition to the scale and electrical attachments, sight-box, candle-balance, micrometer cock with its standard burner, the instrument is furnished with a delicate governor for regulating the pressure to any degree, from the highest point furnished by the gas companies down to the lowest minimum at which gas will burn to advantage, an arched pressure guage for indicating the same, and a test meter for recording the exact quantity of gas consumed during the test. This meter is so constructed that it will register one-twelfth of a cubic foot in one revolution of the measuring-drum, because one-twelfth of a cubic foot per minute will be equal to five cubic feet per hour, the standard quantity. The dial of the meter is arranged for ascertaining the number of revolutions which the meter has made during the time occupied in performing an experiment. In order that the water-line of the meter may be always known, and, if necessary, easily corrected, a water-guage is attached with the true water-line marked thereon. Lubricators are also fitted to the front and back bearings of the shaft of the measuring-drum, for the instrument is only correct when the working friction is the same as at the time it was proved. In the body of the movement there is also placed a clock which will accurately define one minute, and provided with an arrangement for starting and stopping instantly. This is required in order to ascertain the rate of the consumption, not only of the gas but also of the candle, as it would be quite difficult to correctly ascertain the exact consumption of one or two candles and observe the illuminating power of the gas in one minute, hence a certain number of minutes should be taken, so that a proper average of the consumption of the candle may be arrived at. Practice has shown that the best experiments are usually performed in ten minutes, therefore the clock has, in addition to the minute hand, an arrangement for showing how many minutes have elapsed from the commencement to the end of an experiment.

It is claimed that this is the most complete instrument ever invented for photometrical purposes, and the accuracy and facility with which our daily experiments have thus far been made, prove beyond question that the claim is well founded.

In order to insure absolute accuracy there is also attached to the photometer a "standard cubic foot" so arranged that one cubic foot of gas can be passed through the meter under any pressure required, there being a pressure gauge attached to indicate the same at any moment; also a thermometer so arranged within a glass tube that the gas, in passing from the cubic foot to the test meter must flow around the thermometer, the temperature of which can be readily observed. This cubic foot is a duplicate of the one furnished to the U. S. Government Inspector for the District of Columbia. Its capacity is 62 321-1000 lbs. of distilled water at a temperature of 62° Fahr., and with the barometer at 30 inches. It is so constructed that it can readily be detached from the photometer and suspended within a copper tank so arranged that "provers" (the instrument used for testing consumers' meters) can also be tested for their accuracy. Finally the photometer is furnished with a full set of "Sugg's improved standard burners," capable of testing gas as low as ten candles, although there are companies furnishing gas of from eighteen to twenty-two candles. The standard burner is so constructed that the quantity of gas it is made to consume per hour shall be permitted to arrive at the point of ignition by an easy and regular flow, without eddies, and at such a velocity that after passing through the hole or other aperture in the top, the particles of carbon contained in the gas shall not be forced out at the top of the chimney until the atmosphere shall have had time to raise them to a sufficiently high state of incandescence, both to render them luminous to the fullest degree and thoroughly consume them.

The sizes of standard burners are as follows:

FOR 16-CANDLE GAS

External diameter, 1.10 inches across the top.
Center aperture, 0.55.
Diameter of holes, .066.
Chimney, 7 inches long; internal diameter, 1 7-8 inches; steatite top, 15 holes, perforated regulator for air.

FOR 18-CANDLE GAS.

External diameter, 1.10 inches across top.
Center aperture, 0.60.
Diameter of holes, 0.06.
Chimney, 7 inches long; internal diameter, 1 7-8 inches; steatite top, 15 holes, perforated regulator for air.

For gases of higher or lower illuminating power the number of holes, central aperture, outside diameter of burner, and length and diameter of chimney are varied to suit the gas; this is absolutely necessary for securing the best results from the gas.

The foregoing described apparatus is placed on a properly constructed table, in a room so arranged as to insure a nearly uniform temperature, well ventilated and free from draughts. The walls, ceiling and floor are painted a deep dull black, and windows so darkened that not a ray of natural light can enter. Pipes connecting with the mains of the several gas companies are so arranged that, by turning a cock, gas from either company can be introduced to the photometer as may be desired.

In the experiments for illuminating power, the following points are observed:

The gas supplied by each gas company is tested daily.

The disc of the photometer is carefully noticed, to see that the paper is perfectly smooth.

The chimney is kept perfectly clean.

The candles are such as are described in the "London Gas Act," of 1860, namely sperm candles of six to the pound, each burning at the rate of 120 grains per hour.

Two candles are used together, one whole candle being cut in the middle, and each piece burned from the centre toward the ends.

The burner used is the Sugg-Letheby Standard, with 15 holes, and chimney 7 inches long by 1 7-8 inches diameter.

The quantity of gas burned is regulated to 5 cubic feet per hour, when possible. With the Mutual gas, however, this cannot be done; in which case the gas is pushed to the verge of smoking.

The gas is allowed to burn continuously for fifteen minutes before the testings begin, and the candles are allowed to attain their normal condition, namely, a bent wick with glowing tip, and an even and dry cup.

In no case is the gas or candle interfered with during the testings.

Each testing includes ten observations made at intervals of one minute.

No test is considered satisfactory if the gas or candle consumption varies greatly from the normal quantity.

The candles are carefully weighed before and after each set of observations, and if the rate of consumption should be more or less than 120 grains per hour, the necessary correction is made.

Correction is also made for the gas consumption when the ratio is more or less than 5 feet per hour.

The meter clocks are tested once in each week, and the meters once a month.

The height of the barometer and the temperature of the gas is observed at the testings.

PRESSURE.

As the pressure under which gas is burned has much to do with the quantity consumed and its illuminating power, and as the contracts of the gas companies require that the burners supplied to the public lamps shall be of a capacity to burn, and shall burn

three cubic feet per hour under a pressure of one inch of water, instruments for accurately recording the variarions of pressure on the mains of the several companies have been placed in the photometer, rooms. These are called Pressure Registers, and they are so constructed that any variation of pressure will raise or lower a float or holder placed within a tank. From the top of the holder a rod extends upward to a vertical drum, around which is coiled a ruled paper divided by twenty-four vertical lines, one for each hour, and horizontal lines 1-10th of an inch apart for the pressure. The drum is made to revolve once in 24 hours, by a clock placed above it, and properly connected for that purpose. On the top of the rod extending from the drum is placed a lead pencil pressing with a light spring against, and marking the ruled paper; thus a sudden pressure being communicated to the holder, and withdrawn immediately, the rod with the pencil will rise and descend, thereby marking a vertical line; but if the pressure should be continuous for any protracted period, the line will be indicated by the length of the horizontal line in relation to the vertical line. The importance of noting the pressure at which gas is furnished may be seen, when it is stated that an increase of four times the pressure will double the discharge, and vice versa; for instance, if gas is furnished to a burner consuming, say five feet per hour, at a pressure of two inches, and, if from any cause the pressure should be reduced to one half inch, then the consumption would be reduced to two and one half feet. The illuminating power is also greatly influenced by the pressure and quantity consumed. For instance, if a burner consuming five feet of gas per hour under one-tenth of an inch pressure, should give a light equal to twelve candles, and the orifice is so restricted that a pressure of 10-10ths would be required to pass five feet in the same time, then the light would be but 2½ candles, and if restricted so that 40-10 would be necessary to pass five feet in the same time, then the light would practically be reduced to nil. Again, if say, gas passing through a burner at the rate of five feet per hour (just one half), then the illuminating power would be but three candles. It can, therefore, be readily seen that pressure and quantity of gas consumed in a given time are important factors in the proper consumption of gas.

The following statement will show the average maximum and minimum pressure of the several gas companies, at Grand and Centre streets, as indicated by the pressure registers in the photometer room:

Gas Companies.	Average Maximum Pressure.	Average Minimum Pressure.	Distance from Gas Works.
	Inches.	Inches.	Miles.
New York Gas-light Co....	1.6	1 4	2 4-100
Manhattan Gas-light Co...	2.6	1.1	1 83-100
N. Y. Mutual Gas-light Co.	2.9	1.2	1 79-100

The above is the average pressure during the 24 hours, at the point mentioned, the highest being the night, and the lowest the day pressure. It will be seen that there is but slight variation in the pressure of the New York Company, which, I presume, is caused by the fact that this company has a very large day consumption, which compels a nearly uniform pressure at their works. The night pressure of the Manhattan and Mutual Companies, as will be seen, is largely in excess of day pressure, in consequence of their gas being mostly required during the night, hence the pressure must be graduated hourly according to the amount of gas presumed to be required. The pressure shown at the photometer-room gives no indication of what it may be in different sections of the city, which, of course, will vary, more or less, according to the distance the gas is to be sent, and also in consequence of the unevenness of the ground. In order to maintain a pressure at the extremities of a district, and on the low lands, sufficient to provide an adequate supply of gas, an excessive pressure must be produced on the high lands and intermediate points. The importance of maintaining a nearly uniform pressure throughout a gas district, is well understood by all gas engineers, but how to do so is a problem they have not yet been able to solve.

It is essential, from time to time, that the pressure existing at certain portions of a district should be known, and hence, some half dozen points are selected for the purpose, consisting of both high and low grounds. Inspectors are then detailed for these points and provided with a small pressure gauge, which is placed on a street lamp post: the gauge is then examined every half hour or hour, and the pressure noted. This is an inconvenient method, as the Inspectors are required to travel from point to point and note the pressure on the gauge; therefore, to obviate much trouble and simplify the work, I suggested to Mr. Goodwin the possibility of devising, if possible, a Portable Pressure Register, convenient and simple in form, and small enough to be placed inside of a lantern on our city lamp posts, and capable of registering a pressure of four inches. This he has succeeded in doing, and one has been forwarded to me and is now on exhibition in this office. It is compact and convenient, and seems to admirably answer the desired purpose, and I have no doubt but that it will be appreciated by all gas companies or other parties having occasion to know the pressure existing in different sections of a city; as by this instrument, the pressure is automatically registered during the entire twenty-four hours.

IMPURITIES.

As sulphur and ammonia are impurities constantly found in gas, and should be removed as far as possible in its manufacture, it is necessary to have certain forms of apparatus to determine the presence of these impurities, and the quantity remaining in the gas as furnished for consumption. It may be observed, concerning the purity of gas. that it can be considered and pronounced commercially pure, and, in the ordinary sense of the term, free from all noxious elements, when after a lengthened exposure to the usual tests for carbonic acid, ammonia, and sulphuretted hydrogen, no indications of these impurities exist. When burned in that state it is less injurious, in a sanitary point of view, than either oils, tallow or wax. With reference to the maximum quantity of impurity in each form with which gas may be allowed to be charged, it should not exceed the following?

Sulphuretted Hydrogen.—All gas should be wholly free from this impurity.

Ammonia.—The maximum amount of this impurity should not exceed five grains in 100 cubic feet of gas although the Metropolitan Gas Referees of London fix the limit at 2½ grains.

Sulphur compounds, other than sulphuretted hydrogen.

The maximum amount of sulphur allowable should not exceed 20 grains per 100 feet.

From the preceding it can be readily understood with what extreme delicacy the modern method of testing gas is observed.

The tests usually applied for ascertaining the purity of gas are, for ammonia, turmeric, or reddened litmus paper and hydrochloric acid; for sulphuretted hydrogen, acetate of lead paper, and for carbonic acid, lime water. For the purpose of properly detecting these impurities instruments have been placed in the laboratory called sulphur and ammonia test burners. It consists of a cup, constructed with a mercury seal, in which is placed a glass receiver; the gas enters from the bottom of the cup and passes through the receiver to an exit tube at the top, fitted with a small burner, at which the gas enters, and show at once by their discoloration the presence of either sulphuretted hydrogen or ammonia. This test, however, merely shows the presence of the impurities, but gives little or no indication as to the quantity. To ascertain the amount of sulphur contained in a given volume of gas, a very different apparatus is required. Having first determined the presence of ammonia, it is then essential to arrive at the quantity, and for this the following apparatus is used. A test meter so arranged as to show any consumption from .001 to 100 cubic feet, the meter being fitted with a double dry governor; an ammonia tube, filled with beads, called a saturator; a deci-gallon measure, viz.: 7,000 grains; burettes holding 700 grains, divided into 100 parts; pipettes, graduated to contain 700, 350, 140, 70 and 35 grains. With the aid of this apparatus a standard solution of acid is made, of which say 70 grains will saturate or neutralize one grain of ammonia. If the saturator is charged with 140 grains of the standard solution, and then 10 cubic feet of gas is passed through the same, and it is found that the standard solution with which the saturator was charged will neutralize but 1½ grains of ammonia, it is evident that the reduction of its neutralizing power must be caused by the ammonia in the ten feet of gas passed through it, which would equal five grains in 100 cubic feet.

For the determination of sulphur two kinds of apparatus are generally used, one known as Dr. Letheby's, and the other as the Referee's. The first consists of a test meter with double dry governor—same as used for ammonia, a glass cylinder about 13 inches long and 4½ inches in diameter, one end of which is fitted to a bent funnel or trumpet tube, so arranged as to cover a "Leslie" gas burner; through the center of the burner there passes a funnel, the larger end of which is placed over a beaker containing a strong solution of ammonia, from the other end of the glass cylinder there extends a glass tube of about ¾ inch diameter and from three to four feet long, all of which is supported upon a wooden stand. The other, or the Referee's consists of a glass bubbling jar, filled with marbles for condensing surface, to which is attached a trumpet tube, covering a burner, around which is placed lumps of carbonate of ammonia; from the jar there passes a tube for carrying off the carbonic acid gas; the condensation falls into the beaker, and is there treated in the same manner as with the Letheby apparatus. This apparatus is fixed in a room capable of being kept at a temperature not lower than 60° Fahr., free from the sulphur disengaged from fires or gas burning in the room, and well ventilated, so that no draught of air can affect the flame or the apparatus. The chemical reaction, upon which the analysis for sulpher depends, is as follows:

Gas contains hydrogen, carbon, and sulphur, which in the process of combustion, combine with the oxygen of the atmosphere and form water, carbonic acid and sulphurous acid; the last being speedily oxidized, more or less completely, into sulphuric acid; ammonia being present—in the beaker referred to—the acids unite with it, ammonic carbonate and sulphate being formed, which are thrown down in a solution with the condensed water of combustion, condensed on the surface of the glass cylinder and tube. A certain portion of this water of condensation is then treated with hydrochloric acid to render the same acid; to this solution is then added a solution of baric chloride, after which it is boiled for a few minutes, or until no further additional milkiness is produced in the liquid; a white precipitate will then fall and leave the liquid quite clear The liquid is then filtered and the powder thoroughly washed; the powder and the filter are then placed in a platinum crucible, the weight of which has been accurately determined in a sensitive balance. The crucible and contents are then heated in the flame of a "Bunsen" burner, the effect of which will be to consume the filter. When the crucible is cold it is reweighed, and the difference between the weight and that previously recorded will be the weight of the powder contained therein, which is baric sulphate, and from this can readily be determined the amount of sulphur contained in the gas. The scale used in weighing the baric sulphate is sensitive to the one-thousandth of a grain, and it is placed within a glass case for protec-

tion against draughts of air, dust, etc. The following table will show the amount of sulphur and ammonia found in the gases of the New York, Manhattan, and New York Mutual Gas-Light companies:

Gas Companies.	Sulphuretted Hydrogen.	Sulphur. (Grs. in 100 cu. ft.)	Ammonia. (Grs. in 100 cu. ft.)
New York Gas-light Co....	None.	42.72	1.33
Manhattan Gas-light Co...	None.	23.04	2.71
N. Y. Mutual Gas-light Ca.	None.	12.52	1.20

The above results were obtained by the Referee's apparatus, and the amount of gas burned was 10 cubic feet, the volume being corrected to the standard barometric pressure of 30 inches of mercury and the temperature of 60° Fahr.

In connection with the apparatus already described, there is an instrument, designed by W. W. Goodwin, for the determination of the density and specific gravity of gas by what is known as the effusion method as first introduced by Prof. Bunsen. By this instrument the specific gravity of gas can be determined with great accuracy in a very few minutes. This method is based on the fact that the specific gravity of two gases which stream out of a fine opening in a thin plate are very nearly proportionate to the square of the time of effusion; for instance, if a given volume of gas flowed through the orifice in 90 seconds, and the same volume of air required 139 seconds, then by dividing the square of the gas time by the square of the air time, the specific gravity would be shown as follows:

$$\text{Gas time, } \frac{90^2}{139^2} = \frac{8100}{19321} = 419 \text{ spec. grav.}$$

Air time,

The following is the specific gravity of the gas tested at the photometrical rooms of this department:

N. Y. Gas,.....sp. gr., .469; illum. power, 16.98
Manhattan Gas,.... " .468; " " 17.87
N. Y. Mutual Gas, " .691; " " 20.09

Assuming that gas is pure, its specific gravity is about as follows:

16 candle gas..... 455
17 " ..... .468
18 " ..... .482
19 " ..... .495
20 " ..... .508

The tests for the specific gravity of gas in comparison to its illuminating power, however, cannot be relied on, because coal gas is a compound of a variable mixture of gases, having, in some instances, similar specific gravities but very different powers of illumination. Thus olefiant and carbonic oxide are both contained in coal gas and possess about the same specific gravity, but the first is one of the most powerful agents used in the production of light, whilst for this purpose the last is absolutely useless. Again, the presence of either sulphur, ammonia, carbonic acid, or atmospheric air will increase the specific gravity and at the same time reduce the illuminating power.

The photometer room has also been provided with a five-foot meter prover, with a connection for the pipes of either gas company, and by this, meters can be tested, if necessary. Also, with suitable test-meters for determining the consumption of gas by different kinds of burners, by observations of one minute' under any degree of pressure.

During the past month a suite of two rooms has been procured in Seventy-ninth street, and the apparatus for the same is now in course of manufacture. It is expected that this place will be in operation within the next two weeks, and then the gases of the Harlem and Metropolitan companies can also be examined.

The apparatus having been fitted up, it then became necessary to obtain the services of a competent person for the making of the different tests, and in order that equal and exact justice should be done as between the gas companies and the people, it was essential that the person so employed should have no interest, direct or indirect, in any of the gas companies of this city, and also be entirely free from bias. In addition to his knowledge of the use of the photometer, he should understand the nature of illuminating gases and be familiar with the practice of chemistry. These requirements, I believe, have been met by the employment of Mr. Edward G. Love, of the School of Mines, of Columbia College, he having had much experience with one of the most eminent chemists of this country.

With the facilities afforded by the foregoing enumerated apparatus, and the completion of the rooms in Seventy-ninth street, the Department of Public Works will be in a position to thoroughly test and settle all questions that may arise as to the illuminating power and purity of the gas supplied by the several gas companies of this city, and it is confidently believed that no public office in this or any other country will be better fitted for the inspection of gas.

All of which is respectfully submitted.

S. McCormick,
Superintendent of Lamps and Gas.

Report of a Committee of the Board of Aldermen of the City of Boston upon the Petition of R. M. C. Graham and others to Establish the Manufacture of Water Gas in that City.

[From the Boston Transcript, Dec. 4, 1877.]

At a regular meeting of the Board of Aldermen, held on Monday, Dec. 3, 1877, Alderman Thompson submitted the following:

The Committee on Lamps, to which was referred the accompanying petition of R. M. C. Graham and others, to lay gas mains and manufacture gas in the city of Boston, submit the following report:

Your committee have given such careful attention to the subject referred to them as the importance of the question demands. They have personally visited New York and the works of the Municipal Gas Co. there, which is understood to manufacture its gas under a process and a patent like those proposed to be employed here. They do not profess to be experts in chemistry, or in the manipulations of the various materials used by different companies to produce gas of a good illuminative quality, but they have given to the various bearings of the subject such careful examination as enables them, in their opinion, to form an intelligent judgment on it.

There is no question that an article which at first was a luxury has now become almost a necessity in every household, and we hold it to be the duty of every municipal corporation to know that the gas distributed through the streets under its charge shall be of good quality, and sold at a price for public and private consumption which shall be fair and just.

It is fortunate that the merits of the whole case should have received so recently a full and exhaustive examination from the Gas Commissioners of the city of Boston, who spent more than a year and a half in the investigations from which they derived their conclusions; and it will be seen in the progress of this report how largely we are indebted to them for statements of facts, explanations of processes of manufacture, and the logical conclusions to which their examinations led.

As shown by their report there are substantially but three processes of gas making which have any considerable use. First—Coal gas, which furnishes the only illuminating gas for all the great cities of Europe, and of Boston and Philadelphia in this country; second, petroleum or naphtha gas, in partial use in some towns and cities in the United States; third, water gas, in moderate use in half a dozen different processes in this country.

Neither of these processes has been substantially improved since its invention, although each has been simplified, and advantageous changes in the details of manufacture have been made.

Full descriptions of the comparative values of each of these forms of manufacture are to be found on pages 9 to 33, inclusive, of the commissioners' report.

The petition now before us for consideration is for permission to introduce a form of water gas now in use in the city of New York.

Of the character of this gas it is sufficient to say that its use was forbidden in the city of Paris on account of the large amount of carbonic oxide which it contained, which a scientific commission of eminent chemists reported that it would be dangerous to introduce, even by way of experiment.

By a law which passed the New Jersey Legislature at its last session, no gas is allowed to be sold in the State which contains more than two per cent. of carbonic oxide. In explanation of this it may be stated that carbonic oxide is a gas of so poisonous a character that one volume of it diffused through one hundred volumes of air renders the latter unfit to sustain life.

It is said by the commissioner to be a pure physiological poison producing death atmost as readily when diluted as when pure.

We here subjoin an analysis of the gas furnished by the Municipal Company by Prof. Henry Morton of the Stevens Institute of Technology, Hoboken, New Jersey, a distinguished chemist, during the past summer.

Constituents.	Per cent. in volume.
Carbonic acid	.21
Oxygen	.14
Olefiant gas and like "illuminants"	15.12
Benzine vapors and like "illuminants"	1.13
Carbonic oxide	26.18
Hydrogen	27.29
Marsh gas	25.43
Nitrogen	4.45
	99.96

The amount of carbonic oxide here shown, viz., about twenty-six per cent., is, in my opinion, quite enough to render this gas very dangerous in view of the liability to leakage and escape which exists in its distribution and use. The amount of carbonic acid which this gas will develop in burning will also be about fifty per cent. more than that produced by ordinary coal gas.

Carbonic acid, as is well known, is fatal to life immediately if present to the extent of thirty per cent. in the air inhaled, and produces serious injury if present to the extent of even one or two per cent. in air which is inhaled for a long time.

"Carbonic oxide is, however, far more poisonous, and is stated to produce fatal effects when present even to the extent of three per cent. in the air inhaled; even very minute quantities producing severe symptoms of headache, giddiness, etc., in a short time."

Before considering specifically in detail what the petitioners desire, it is obvious that the establishment of such a manufacture must bring into employment additional capital upon which the gas consumers must pay interest. It is worth while to look for a moment at the price of gas as affected by the capital employed to manufacture and distribute it.

There is invested in the city of New York in gas capital and bonds the sum of $20,750,000, or $20.75 to each inhabitant on the basis of 1,000,000 population.

With recent proposed additions, Brooklyn will have invested a capital of $11,845,000, or $23.69 to each inhabitant, estimating the population at half a million.

In the large district supplied by the Boston companies, $5,333,000 is invested, or $15.24 to each inhabitant, on the basis of 350,000 population.

The practical result from this is that gas is sold to private consumers by every company but one in New York and Brooklyn at $2.50 per 1000 cubic feet, while in Boston proper it has been for many years sold at a

lower price than in either of those cities, and the price is now $2 25 per 1000 cubic feet.

The general reasons for this result may be found in the masterly statement of John Stuart Mill, quoted in the hearing before the Board of Aldermen in 1874, page 124, and in the Commissioners' report, pages 60 and 61.

"When, in any employment, the regime of independent small producers has either never been possible, or has been suspended, and the system of many work-people under one management has become fully established, from that time any further enlargement in the scale of production is generally an unqualified benefit. It is obvious, for example, how great an economy of labor would be obtained if London were to be supplied by a single gas or water company, instead of the existing plurality. While there are even as many as two, this implies double establishments of all sorts, when one only, with a small increase, could probably perform the whole operation equally well; double sets of machinery and works, when the whole of the gas or water required could generally be produced by one set only; even double sets of pipes, if the companies did not prevent this needless expense, by agreeing upon a division of the territory. Were there only one establishment, it could make lower charges consistently with obtaining the rate of profit now realized. It is, however, an error to suppose that prices are even permanently kept down by the competition of these companies. Where competitors are so few, they always end by agreeing not to compete. They may run a race of cheapness to ruin a new candidate, but as soon as he has established his footing they come to terms with him. When, therefore, a business of real public importance can only be carried on advantageously upon so large a scale as to render the liberty of competition almost illusory, it is an unthrifty dispensation of the public resources, that several costly sets of arrangements should be kept up for the purpose of rendering to the community this one service. It is much better to treat it at once as a public function; and if it be not such as the government itself could beneficially undertake, it should be made over entire to the company or association, which will perform it on the best terms for the public. In the case of railways, for example, no one can desire to see the enormous waste of capital and land (not to speak of increased nuisance) involved in the construction of a second railway to connect the same places already united by an existing one, while the two would not do the work better than it could be done by one, and after a short time, would probably be amalgamated. Only one such line ought to be permitted; but the control over that line never ought to be parted with by the State, unless on a temporary concession as in France; and the vested right which Parliament has allowed to be acquired by the existing companies, like all other proprietary rights which are opposed to public utility, is morally valid only as a claim to compensation."

In this connection we quote to the same point from the commissioners' report, p. 61, as follows:

"In the early days of railroads in this country and England competition was regarded as the sovereign remedy for high rates of transportation; but the result has shown that a vast waste of capital, and compelled the public to pay interest on the cost of many lines which should never have been built. In gas companies the result has been the same, wherever competition in the same district has been carried to its legitimate and necessary issue. But one line of main pipes was necessary to supply the public wants, and wherever two were laid, in some form or other, the consumer must pay the cost upon the unnecessary expenditure. Such a competition has led to precisely the result which might have been expected, a combination of or compromise between the companies, and an increased rate of gas to the consumers to pay the interest on the unnecessary waste of capital.

"While the public interest in the proper and economical management of gas companies is less in extent than that in the management of railroad corporations, it is precisely of the same nature. Both are and must remain monopolies. Both are liable to be conducted arbitrarily and in a manner to injure and abuse. The railroad corporations of this State have been always controlled by law, while the gas companies have been left to pursue their way unchecked and untrammelled; and it is due to their managers to say that, in most instances, they have not abused the license they have enjoyed."

The advantages which the petitioners offer are two—a nominally lower price for the gas for the street lamps, including the care of the lamps; and a lower price for the gas used in the public buildings; with respect to the price to be charged to private consumers nothing is said in their proposals.

As regards the street lamps, they propose to use three-feet burners, as is done in New York, where the lamps are placed 100 feet apart.

In Boston, burners consuming not less than four feet per hour are used, and the lamps are 150 feet apart.

It will be seen, therefore, that to cover the same space which is now lighted by two lamps there must be, by the new plan, three lamps, the cost of which will be $75 per annum.

The experience of the lamp department shows that this is a little more than it now costs in the city proper.

As regards the public buildings the quantity of gas used is so small as not to be worth considering.

Whatever saving there might be would be far more than offset by the injury to the streets and the inconvenience to the public.

The whole cost of gas for the public buildings, for the year ending May 1, 1877, was $39,200.28. Of this sum $24,378.62 was paid to the Boston gas-light company, for the gas furnished to the buildings in the city proper.

At the price at which the petitioners propose to furnish gas the cost would have been but $1500 less; and this saving is all the advantage which the city would derive from the grant of a perpetual right to a new corporation to break up the pavements and interrupt public travel whenever the necessities or convenience of the new corporation might require.

These are the considerations which are offered the city of Boston as reasons for the investment of further capital in the business, for the injury to be done to the streets, and for the erection of works, of the dangerous character of all works where naphtha is used,

In this connection we may quote advantageously some of the conclusions of the gas commissioners.

"I. That the citizens of Boston are being supplied by the Boston gas-light company with gas of excellent quality, and at a price, in comparison with the cost of coal and the quality of the gas, lower than in most of the cities of the United States. No fair comparison can be made in regard to price with European cities, on account of the great difference in the cost of labor and material, and the value of residuals.

"II. That there are other processes than those in use in the various companies in this city by which illuminating gas can be made, and for which great improvements in regard to cost and quality are claimed. At this present time, however, it would probably be impossible for a large gas company like the Boston gas light company, to make use of any process for the manufacture of illuminating gas from naphtha or petroleum, without either paying a considerable royalty or becoming involved in a lawsuits for the alleged infringement of some patent. It is, nevertheless, doubtful whether any of the patents for using petroleum or naphtha in gas-making are valid. We advise most decidedly against the admission of another private gas corporation within the limits of Boston to compete in the sale of gas with the existing companies, as being disadvantageous to the public generally."

In the course of our investigations we have visited the gas works in this city and the largest gas works in New York, as well as the Municipal gas company works, and we find the works of the Boston gas-light company fully up to the standard of the best works which we have visited; and we believe that it is admitted by all gas engineers that their apparatus for experimental purposes is not surpassed by any in the country.

Your committee are of the opinion that it is not for the interest of the city to grant permission to another company to dig up its streets in order to try the experiment whether cheaper or better gas can be made from some other material than coal.

It is for the interest of every gas company to make its gas as cheaply as possible; and all experiments for this purpose may be safely left to the companies already established.

If the experiment succeeds, the new process or the new material is sure to be adopted by the watchful and intelligent managers of gas companies.

If it fails, no great harm has been done. But if new works have been built and new mains have been laid in the streets to try an experiment which proves to be unsuccessful, the community is at once subjected to a heavy loss in addition to the inconvenience and ultimate loss which have been found to follow invariably from the acts of competing gas companies; no one has been benefitted except the contractor for building the works.

Your committee, for the reasons herein set forth, recommend that the petitioners be granted leave to withdraw.

FRANCIS THOMPSON,
GEO. DUNBAR,
R. W. ROBINSON.
Committee on Lamps.

Laid on the table and ordered printed, on motion of Alderman Thompson.

Correspondence

[Correspondents, in all cases, should sign their communications with their names and address in full—not for publication, unless desired, but as a guarantee of good faith.—ED

"A Chapter of Accidents."

OFFICE NATIONAL COAL GAS CO.,
4 WARREN STREET, N. Y.
December 6, 1877.

Mr. Editor: In your last Journal, of December 3, under the above heading, you refer to the late explosion at Indianapolis, and say, "at New London, Ct., and at Utica, N. Y., similar 'accidents' have occurred with water gas."

You seem, therefore, to give emphasis to *water gas* as the cause of the explosions, without any distinctive reference to the *process* under which it was made being faulty and unreliable, and therefore likely to produce such "accidents."

I shall not attempt to explain how the explosions you refer to occurred, but I am very sure that if water gas is made *by a proper process*, there is not a particle more danger from it than from coal gas. I speak thus confidently, because under our "Allen-Harris or American Hydrocarbon Process," I have abundant evidence to sustain my assertion. During the past eight years, through all the stages of our progress to our present perfected system, our water gas has been used in almost every form. It has been sent from the decomposing retorts where it is made, into retorts containing gas coals, to take up the excess of carbon there, and into the hydraulic mains to unite with cool gas there. It has been sent into a separate gasholder, and from thence used for fuel. It has also been sent red hot from the retorts to the furnace beneath, and used as fuel to heat the bench in which it was made. And over 100,000,090 cub. ft. of splendid illuminating gas have been made in connection with petroleum or naphtha, under our process.

The Citizens Gas Company, of Poughkeepsie, N. Y., have for two and a half years supplied that city with such gas, and since the 9th of November last, have lighted the Hudson River State Hospital at Poughkeepsie, situated about nine miles from the works.

In June, 1875, that company commenced with about nine miles of street mains, which they filled for several days with water gas from the holder (in a manner similar to what is said to have been done at Indianapolis), until they had thoroughly tested the pipes, and freed them from air. They then added their oil to it, and from that day to this, they have given to Poughkeepsie a most satisfactory and brilliant gas, They now have about eighteen miles of street mains

and the number of connections also made during that time has been so many, that instead of a delivery of only 732,000 feet of gas in July 1875, their delivery of gas in November last was 2,220,000 feet, notwithstanding about 530 street gas lamps were off four nights, on account of the moon, as per contract with the city.

During the eight years, and with all the experience and facts to which I have alluded, *there has never been any explosion of our water gas, or under our process, of any kind whatever*, nor even any indications that required precautionary measures to prevent an explosion; nothing whatever beyond the ordinary care used in the making of coal gas.

For several years we were much troubled by the cracking of the common clay retorts, as under our process, there is no excess or waste of carbon to fill the fractures, as in making coal gas; and these were the only "accidents" to which we were subject. But they have been all obviated by the new patented double clay retort, which is another valuable American invention, and proved to be the "missing link" in our apparatus.

All the water gas explosions that I have heard of, have occurred in connection with the use of the "cupola" for making the gas, and that process is so wholly different from ours, that whatever danger may arise from that, has no bearing upon us. Although we own the old Gwynne patent for the cupola for making gas, which anti-dates the de Motai patent some six years, and the Lowe patent some ten years, yet we consider the alternate blowing in of air and making gas in the same structure containing fire, to be so objectionable that we would not use it. But others must judge for themselves. My only object is to show that if explosions follow in the wake of the cupola, whether they can be satisfactorily explained or not, one thing is certain, that the danger is not chargeable to water gas, but to the mode of making it. Any gas will explode under the same circumstances, whatever they may prove to be when discovered.

And now, Mr. Editor, I hope that so fair and just a man as you are, and all others who mean to be just, occupying places of power and influence, will properly discriminate between *a product* and *a process*, so that those who receive your opinions may not erroneously infer that because one mill operates badly, all flour should be condemned. Yours truly,

H. P. Allen.

Official Report of Examinations of Gas for two Weeks ending Dec. 8, 1877, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

Date. Nov. 1877.	Time of Day at which Test were made.	New York Gas Light Co.	Manhattan Gas-Light Co.	Mutual Gas-Light Co.	Metropolitan Gas-Light Co.	Harlem Gas-Light Co.	Municipal Gas-Light Co.
26		15.86	17.63	19.75	16.15	16.27	
27	Between	16.31	17.52	18.97	16.24	16.12	
28	10 A. M.	16.03	17.68	19.27	16.88	15.92	
30	and	14.68	15.99	17.58	16.94	16.30	
Dec 1	3 P. M.	14.78	15.06	17.85	16.44	16.43	
	Average	15.55	16.76	18.68	16.53	16.21	
3		15.90	16.71	17.68	17.77	16.65	
4		15.59	17.43	19.51	17.27	16.41	
5		16.42	17.09	19.75	17.00	16.32	
6		16.01	17.24	17.91	16.49	16.35	
7		16.72	17.68	19.00	16.66	16.25	
8		16.12	16.54	19.19	17.16	16.36	
	Average	16.12	17.11	18.84	17.06	16.39	

Sugg-Letheby burner.

Bids for Street Lighting in New York City for Four Months from Jan. 1, 1878.

Company.	Gas, Lighting, cleaning, etc.	Lamp-Post straightened.	Column releaded.	Column refitted.	Lamp post removed.	Lamp post reset.	New Lamp fitted up.
Manhattan.....	$ 6.00	1 50	1 50	3 50	3 50	10	10
Metropolitan..	6.90	2	2	3	3	8	8
New York.....	6.00	1 50	1 50	3 50	3 50	10	10
Harlem.....	8.30	3	3	4	4	10	10
Mutual.....	8.88	1 50	1 50	3 50	3 50	10	10
Yonkers.....	12.00	1 50	1 50	3 00	3 00	8	8

The Globe gas-light company bid for 2000 lamps (four feet burners) at $8 per lamp; Jas. Bryan bid for the same kind of lamps, at $11.33 per lamp.

For furnishing gas to the various public buildings, the following were the prices bid:

Manhattan, $1.90; New York, $1.90; Metropolitan $2.25; Mutual, $2.00; Harlem, $2.75 per 1000 cubic feet.

Notes on the Telephone.

BY PAGET HIGGS.

In the present agitation concerning speaking or telephonic telegraphs, the following extract from M. Le Comte du Moncel's "Exposé des Applications de l'Electricitéé," edition of the year 1857, vol. iii, p. 110, may be interesting as pointing out how nearly the idea has been forestalled.

"*The Electric Transmission of Speech.*—I did not wish to bring forward in the chapter of the electric telegraph a fantastic conception of a certain M. Ch. B——, who believes that it will be possible to transmit speech electrically, because it might have been asked why I had classed among so many remarkable inventions an idea that, presented by the author as it is, is not more than a dream. However, to be faithful to the *role* that I have imposed upon myself of speaking of all the applications of electricity that have become known to me, I wish to quote here the information which the author has published on this subject.

'After the marvelous telegraphs which are able to reproduce at a distance writing of this or that individual, and designs more or less complicated, it seemed impossible, said M. B——, to advance further in the region of the marvellous. Nevertheless, essaying to do something more, I asked, for example, if speech itself would not be capable of transmission by electricicy; in a word, if one would not be able to speak at Vienna and be heard at Paris. The thing is practicable. This is how: Sounds, it is known, are formed by vibrations and carried to the ear by these same vibrations, which are reproduced by the intermediate media.

'But the intensity of these vibrations diminishes very rapidly with the distance, from which it follows, even in the employment of speaking trumpets, tubes, and of aconstical horns, the limits which cannot be surpassed are very restricted. Imagine that one speaks near a mobile plate, flexible enough not to lose any of the vibrations produced by the voice, that this plate establishes and interrupts successively the communication with a battery. You would not be able to have at a distance another plate which would execute at the same time the same vibration.

'It is true that the intensity of the sounds produced would be variable at the point of departure, where the plate is vibrated by the voice, and constant at the point of arrival, where it is vibrated by electricity. But it is demonstrable that this would not alter the sounds.

'It is evident from the first that the sounds would reproduce themselves with the same pitch in the scale. The actual condition of acoustical science does not permit of saying *a priori*, whether the same conditions would hold good for all syllables articulated by the human voice. The manner in which these syllables are produced is not sufficiently well known.

* * * * * *

'In any case it is impossible to demonstrate, in the present state of science, that the electrical transmission of sounds is impossible. Every probability, on the contrary, is for the possibility. An electric battery, two vibrating plates, and a metallic wire will suffice.

* * * * * *

'It is certain that, at a more or or less distant, speech will be transmitted to a distance by electricity. I have commenced some experiments to that effect, they are delicate and require time and patience. But the approximations obtained point toward a favorable result.'"—*Nature*, of Aug. 30.

What a Gas Manufacturer Ought to Read.

At the last meeting of the British Association of Gas Managers, the President, Robert Paulson Spice, in his annual address, spoke as follows: I cannot shrink from the expression of my opinion that a gas manager should aspire to a scientific knowledge of the material structure of the globe, its place and its path in the universe, and attain to such a degree of familiarity with the sciences of chemistry, geology and astronomy as may enable him to bring to the practical and every-day labors of his life the aid of those great principles which are involved in, and underlie, the solution of the problems which naturally arise, and require his skill in the determination of the right direction to be given in his dealings with the various forces of nature, intimately connected, as they undoubtedly are, with his common avocations, demanding the economical adaptation of the means to the end to be accomplished.

And these being the primary objects of his professional life, I would suggest that he would do well to have on his book-shelves Kingsley's "Town Geology," an elementary and popular work, treating of the soil of the field, the pebbles in the street, the stones in the wall, the coal in the fire, the lime in the mortar, and the slates on the roof; the works of Hugh Miller, entitled "My Schools and Schoolmasters," "The Testimony of the Rocks," and "Old Red Sandstone;" Faraday's popular lectures "On the Various Forces of Nature," and the "Chemical History of a Candle;" "Notes of a Course of Nine Lectures on Light," delivered at the Royal Institute in 1869 and "Six Lectures on Light," delivered in America in 1872-3, by Tyndall; and "Herschel's Outlines of Astronomy."

These several works contain almost inexhaustible and measureless mines of intellectual wealth, calculated to raise the conceptions, expand the intellect and enlarge the resources of the gas manager, place him above the common level of his fellow townsmen, and make his power felt by them, to a degree, and in a way in which it could not otherwise be, quite as much to their advantage as his; and thus it would, in his own experience, prove the truth of Lord Bacon's aphorism, that "knowledge is power," always assuming that the knowledge is accompanied by the twin virtues, discretion and courtesy. The chemist, the geologist and the astronomer each furnish all-important aids to the gas manufacturer and manager, enabling him to trace effects to causes, and to make the best use of materials.—*Mining and Scientific Press.*

Formation of Cannel Coal.—A discovery has been made in Australia which confirms with singular minuteness the theory that assigns to the cannel coal an origin from leaves. It is difficult to understand how leaves can accumulate free from dirt in sufficient quantity to form beds of cannel coal, now several feet thick, and representing their mass many times in leaves. But in Australia just such a mass of leaves has been found, partially but not completely altered to cannel. The appearance and fracture of fresh blocks are the same as of this kind of coal found elsewhere, but after several years exposure it can be separated into thin laminæ, which shows that the mass is composed principally of leaves. The bed is six feet thick, and the government geologists calls it "incipient lignite."—*Mining and Scientific Press.*

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MONDAY, DECEMBER 17, 1877.

Department of Public Works.

REPORT FOR THE QUARTER ENDING SEPT. 30, 1877.

DEPARTMENT OF PUBLIC WORKS,
COMMISSIONER'S OFFICE, ROOM 19, CITY HALL,
NEW YORK, October 31, 1877.

Hon. Smith Ely, Jr., Mayor:

Sir: In accordance with section 27 of the Charter, I have the honor to submit herewith a report of the operations of the Department for the Quarter ending September 30, 1877.

CROTON WATER SERVICE.

The work on the new storage reservoir, in the middle branch of the Croton river, has been vigorously prosecuted, so that there is every assurance of its completion in time to receive the rainfall of next winter and spring. This insures the population against a recurrence of the scarcity and low pressure of water, caused by the severe droughts of this year and last year, as there will be a sufficient quantity of water stored in reservoirs and lakes to supply the deficiency in the natural flow of the Croton river. It will also obviate the necessity of drawing down the water of natural lakes and ponds to any considerable extent, and incurring expense in acquiring temporary water rights and cutting down outlets.

Proceedings have been instituted, under chapter 445 of the Laws of 1877, to acquire the permanent right to draw water from the natural lakes and ponds available for this purpose, and the commissioners to appraise the value of such rights were appointed on the 20th of October, inst.

Since the 29th of June, the volume of the Croton river has been less than the quantity needed for our supply, and 4,020,000,000 gallons of water have been drawn from the reservoir and lakes to supply the deficiency. Much opposition has been made by adjoining property owners against the drawing of water from Lake Mahopac, and large amounts demanded for alleged damages. When the department declined to pay such demands, and asked for the appointment of commissioners of appraisal, some of the claimants proceeded to fill up the outlet of the lake, and the department was compelled to send a large force of workmen to reopen it and protect it from further interference. Fortunately, the recent rains have so increased the volume of the Croton river, that recourse to the lakes is no longer necessary this season, and by the next summer the question of compensation for the right to draw water from them will be definitely settled by legal process.

In addition to the ordinary repairs of the aqueduct, the work of strengthening the structure by raising the protection walls and adding to the side embankments has been continued to the full extent that the limited appropriation would allow.

At Yonkers it was necessary to build 700 cubic yards of protection wall and 100 cubic yards of retaining wall to protect the aqueduct from injury by excavations on adjoining private property.

During the quarter 19,263 buildings were inspected to detect waste of water, and it was found that waste occurred in 4,105 places, and that in 3,703 cases it was due to leaks in the plumbing, and in 402 cases to wilful neglect to close faucets.

Considerable progress has been made in applying water meters along the water front and to large stables, manufacturing and other establishments where water is used and wasted in large quantities. All the horse car and omnibus stables, and some of the livery stables have been supplied with them, and 46 meters have been placed on piers where water is furnished to shipping.

The department has collected, during the quarter, $29,442.58 for water supplied to shipping, and $3,238.50 for water furnished for building purposes.

Under the several contracts for laying water pipes, to extend and improve the distributing system, as authorized from time to time, by the Common Council, there was laid during the quarter—

5,140	lineal feet of	48-inch pipe.
8,011	"	12 inch pipe.
11,109	"	6-inch pipe.
Total....24,260	lineal feet of	pipe.

To facilitate the extinguishment of fires, 90 large and 37 small fire hydrants were placed in locations recommended by the Fire Department.

WATER SUPPLY—PRESENT AND FUTURE.

The following table shows the rainfall for each month of 1876, and for ten months of 1877, as registered at the Boyd's Corners Reservoir in Putnam county.

	1876.	1877.
January	1.42 inches.	2.68 inches.
February	4.91 "	0.80 "
March	6.33 "	7.66 "
April	4.43 "	2.35 "
May	3.99 "	0.85 "
June	2.52 "	4.95 "
July	3.42 "	4.65 "
August	1.20 "	2.54 "
September	5.21 "	1.49 "
October	1.50 "	8.38 "
November	3.40 "	
December	2,35 "	

The drought of last year in the Croton district will be remembered as one of unusual severity, causing much inconvenience by a scarcity of water in the city. That of the present year, however, has been far more severe, exceeding anything known for a half century; and these two dry seasons, following directly one after the other, will be ever memorable in the records of the city's water supply.

From the preceding table it will be seen that the six months' rainfall, from April to September 30th, was—

In 1876	20.77 inches.
In 1877	14.63 "

Showing a falling-off of 6·14 inches rainfall in the six warm months of 1877 as compared with those of the previous year. This great diminution of rainfall was quite sufficient to account for the diminished supply.

The long-continued drought caused so much anxiety, that on the 28th day of September I issued to the public, through the press, the following letter in explanation of the diminished supply, and asking the avoidance of waste in every form, in order to avert what might become a serious calamity:

"*To the Public.*

"The drought of 1876 in the Croton region and adjacent country—the severest known for half a century—has been followed this season by one of still greater severity, which is seriously affecting the water supply of this city. The equinoctial rains of last year afforded some relief, but the light September rainfall of the present year has been entirely absorbed by the parched ground, leaving none to run into the streams. It is now ninety days since any water ran over the Croton dam into the Hudson river. For some time past large drafts have been made upon the artificial and natural reservoirs of the Croton district—every available lake having been put under contribution; but the long-continued and unprecedented drought warns me to give notice to citizens, and all who use the Croton water, to avoid waste, and to call upon them for aid in this great emergency, by observing the strictest economy in the use of water. The officers and employees of this department have been instructed to exercise the utmost vigilance in suppressing waste, and I have asked the aid of the Police department in enforcing this order.

"It is to be hoped that relief may soon come in copious showers; but it is the part of prudence, and indeed of necessity, to husband with care the present supply until such relief shall arrive.

"I perform an unwelcome but imperative duty for the second time during my brief administration of this department, in notifying the public of a scarcity of water, a scarcity which should not and would not have existed had precautionary measures been adopted four or five years since, as I have heretofore fully explained in official reports and a statement addressed to the public last October.

"The new reservoir on the middle branch of the Croton has been pressed forward during this and the past season with much energy, but it cannot be brought into use before the close of the present year. Its capacity is nearly four thousand millions of gallons, and it will alone afford a supply for fifty or sixty days. This great reservoir should have been commenced two or three years earlier than the time selected, and, had this been done, no scarcity of water would have been felt either in the past or the present year. Appreciating its great importance, I have done everything possible to hasten its completion, and have taken steps to provide a still further supply by selecting a site for another and larger reservoir, which I propose to put under contract next season.

"In the belief that citizens generally will appreciate the circumstances as above explained, and contribute their aid in averting a serious calamity.

"I am, respectfully,

"ALLAN CAMPBELL,

"Commissioner of Public Works."

This unprecedented drought, and the consequent scarcity of water, have again invited criticism upon our water system, and very natural inquiries as to the probability of the recurrence of the evil. These comments have sometimes been accompanied by vague suggestions for increasing the supply, which, though doubtless, in most instances, well meant, are generally of a crude and chimerical character. In my previous quarterly reports, I gave some account of our water system, and my views as to the best plan of securing an abundant supply, not only for the present time but for the future, when New York shall have increased two or threefold in population.

Unfortunately, during my brief administration of this department, the Croton region and adjacent country have been subject to drought in two successive seasons, unexampled in the history of that part of the state. This drought occurred while important works for increasing the supply of water, though in progress, were yet incomplete, and hence the inconvenience from diminished quantity and pressure. As stated in the foregoing letter to the public, had the large storage reservoir now constructing on the middle branch of the Croton river been ready for use, no scarcity would have been felt, even in the past season of exceptional drought.

Citizens generally, however, who only know that their water supply is reduced, and that they are discomforted thereby, are oftentimes inclined to condemn the source of supply as inadequate and the whole water system as a failure; but such judgment based upon a temporary and exceptional deficiency is incorrect. It is not the plan or system which is at fault, but the Department and officials in charge, who have failed to fulfill their duty in providing the necessary works and appliances in ample time to meet the increasing demands of the city, and to provide against such droughts as have occurred for two successive years, and to which every country is sometimes liable.

When the Croton water system was established nearly forty years ago, no storage reservoir beyond that formed by the Croton dam and those within the city limits were necessary; but it was always contemplated that with increase of population, manufactures and commerce, additional storage reservoirs would be required, and with this view complete surveys were made of the Croton water shed by the aqueduct department several years since to ascertain with accuracy its drainage area and the most eligible sites for reservoirs, so that the actual quantity of water which could be depended on might be known, and the reservoirs built from time to time, as needed. Such plan and system, and indeed every plan and system, must necessarily be based upon the assumption that the authorities are to do their duty in the premises. Great reservoirs, conduits and their accessories do not spring into existence when required, and without thought, labor and financial provision. Unfortunately the city government, as is too well known, was for several years not very remote in the past more concerned in promoting schemes of public plunder than in providing means of an increased water supply and other useful improvements, though urged to do so by the engineers of the department. The citizens of New York, who so long tolerated such a government, must suffer the fruits of its fraud and ignorance, and cannot expect honest and competent officials to remedy in a day, or a year, the accumulated evils of many years' neglect. It is therefore unjust to condemn the plan on which our water system is founded, when the evils are not attributable to the system itself and to the sources which nature has supplied, but to the failure of man to carry out in proper time and ways the works necessary to perfect the system. If we were drawing water even from a great river like the Hudson, instead of from the Croton valley, and neglected to increase the pumping power and the area or number of conduits with the increasing demands of the city, as well might it be said that the Hudson was inadequate, when in fact the fault would rest with man and not with nature. We may have a very good plan and system of lighting the city, but if additional mains be not laid and additional works erected to provide an increased quantity of gas for a growing population, it is very certain that some portion of the city would be left in darkness, and this would result not from a defective plan, but from neglect to extend and perfect the system previously adopted.

While I have thought it proper to present these views upon our water system, I make great allowance for the complaints of citizens when deprived of the comfort and conveniences of a full and abundant supply of water, and I admit that it is the duty of this department to see to it that the city is provided in every respect with a sufficient supply of this essential element, and if the Croton system is inadequate to the purpose, then to adopt or recommend some other mode which shall beyond peradventure meet the necessity of the case.

After careful study, and the experience of the late extraordinary drought, I see no reason to alter the opinion expressed in previous report, that the Croton system (with such auxilliary supplies as have heretofore and shall hereafter be indicated) is the most economical, and simplest system, all things considered, which can be adopted.

Amongst other sources of supply which have been suggested, are the Passaic and the Hudson river. The watershed of the former river above the Dundee dam, situated five miles below the city of Paterson, and at the head of tidewater, has an area of about 950 square miles. The cities of Newark, Jersey City and Hoboken take their supply from this river below the Dundee dam, and provision would have to be made to pass them the quantity required for their use. The water, if taken at the dam, must be pumped into a reservoir, and carried thence across Saddle river and under the Hackensack to a proper point eight miles distant; then pumped into a reservoir, and thence led by pipes under the Hudson river to the reservoir in New York. To provide for an uninterrupted supply from this source, the pipes under the Hackensack and Hudson rivers should be carried through tunnels, that they may be readily reached for repairs.

The water of this stream is contaminated by the refuse of manufactures and the sewage of Paterson, a city of large and increasing population. Newark, Jersey City and Hoboken now complain of the quality of the water supplied from this river in time of drought, and are having examinations made for a different and more pure supply.

To tap the river at such elevation that it may be brought into New York without pumping would necessitate the construction of large storage reservoirs and compensation to the mill owners and cities using the water on the lower part of the river, and it is doubtful whether a grant to divert the water could be obtained.

The quantity of water flowing into the Passaic during recent droughts, according to authentic statements, was only one hundred millions gallons per day, or about the quantity consumed daily in New York. Considering the large cities in New Jersey, to be first supplied, the expensive and precarious method required to conduct this water to this city, and other objections which have been mentioned, this plan may be pronounced impracticable.

It has been proposed to pump the water of the Hudson river at Poughkeepsie to the high ground lying east of the river, and thence carry it by pipes several miles to the head waters of the Croton. A description and estimate of this plan was published in Poughkeepsie about a year ago, or after the drought of 1876, and contemplated a partial supply to aid the Croton in meeting such deficiencies. Our present system of storage reservoirs in the Croton valley will accomplish the object at far less expense, and with pure water, that of the Hudson at Poughkeepsie being sometimes brackish.

If the Hudson river shall ever be used for the supply of New York, its water must be taken where it is unaffected by the sea, perhaps one hundred to one hundred and twenty miles above the city, and thence conveyed by aqueduct or pipes in the valley of the Hudson itself to the point of distribution. The cost of such a work over the rough country which borders the Hudson river would be enormous.

There is undoubtedly a great advantage in drawing a supply of water for a large city from a great and never failing river like the Hudson, its capacity being practically without limit, and if there were no other and more feasible alternative it might be well to consider this plan, formidable as it may appear. In the far distant future, when New York shall count its population by many millions, and when the Croton with its adjunct, the Housatonic, shall have been taxed to their utmost capacity, it is a satisfaction to know that the great city can never be deficient in its water supply, the Hudson affording a certain resort, though at great expense.

Another suggestion is that water may be procured from Long Island, by sinking wells in the sands, and conveying the water by pipes under the East river to this city. It has even been asserted that the present supply for Brooklyn is so abundant that a sufficient amount can be spared to supply the lower part of New York, under a pressure of sixty pounds to the square inch. This cannot be true, as during the late drought the Brooklyn Board of City Works was warning its citizens to be sparing of water, the reservoirs being greatly reduced. Even if a supply could be obtained from Long Island, its conveyance by pipes under the East river in any considerable quantity would be attended with hazard.

With this notice of suggestions which have been made for improving the water supply of New York, I will now give my views as to the best mode of securing the end proposed.

FIRST—AS TO THE QUANTITY WHICH THE CROTON WATER-SHED WILL FURNISH.

From a careful survey made by the Croton Aqueduct Board in 1857-'8, it was found that the Croton water-shed embraces an area of 338 square miles. In a report made by the board to the Common Council in 1863, the average daily flow of the Croton was stated to be 339,000,000 gallons.

From the spring of 1866, when the storage reservoir at Boyd's corners was commenced, a rain-gauge has been kept at that point. The elevation is 550 feet above the tide, and the rainfall at that point may be considered a fair average of the rainfall in the Croton basin in a period of twelve years.

From the above data and from daily observations taken at the Croton dam, and in the aqueduct, the following table is constructed, showing the actual rain-fall in the Croton basin, the average amount in gallons of the natural flow of the river daily at the dam, the percentage of rain fall delivered at the dam and the number of days in each year when no water ran over the dam.

Year.	Rainfall at Boyd's Corners Reservoir.	Average Amount per Day of Natural Flow of Croton river at Croton dam.	Percentage of rain-fall.	No. of days when no water ran across Croton Dam.
	Inches.	Gallons.		
1866.....	51.77	441,000,000	51	50
1867.....	50.77	540,000,000	65	...
1868.....	50.33	601,000,000	74	8
1869.....	48.36	457,000,000	58	80
1870.....	44.63	348,000,000	47.5	102
1871.....	48.94	357,000,000	45	37
1872.....	40.74	307,000,000	49	34
1873.....	43.87	444,000,000	67	116
1874.....	42.37	428,000,000	63	83
1875.....	43.66	435,000,000	59	71
1876.....	40.68	368,000,000	56	175
1877.10 mos	36.35	307,000,000*	44	136

* N. B.—The heavy rains of November will largely increase his average for the whole year 1877.

From which it appears that the highest average daily flow in any year was 601 millions gallons, the general daily average for the twelve years was 419 millions gallons, and the minimum average daily flow 307 millions gallons, and allowing 100 millions gallons daily to be delivered by the aqueduct (its maximum capacity), then it follows that even in the driest year over 200 millions gallons daily run to waste, and that, if this were collected and impounded in storage reservoirs, to be delivered as demanded, the Croton basin would supply a population of three millions in number, allowing a consumption of the large quantity of 100 gallons daily per capita.

It would not, perhaps, be practicable to store all the water flowing in the river, and there would be some loss by evaporation, but on the other hand, the per capita allowance can with regulation against waste be much reduced below one hundred gallons daily, and therefore the Croton basin alone may be safely counted on to supply a city of two and a-half million inhabitants.

I have made the above statement because false impressions are entertained by some as to the adequacy of the Croton watershed, founded doubtless upon the reduced supply during droughts. The facts therein presented demonstrate clearly the error of such opin-

ions, and prove that by the construction of the proper works from time to time, always, of course, keeping well in advance of actual need, the demands of the city as it grows in population can be supplied from this source.

But one artificial reservoir has yet been brought into use, viz., that at Boyd's Corners, having a storage capacity of nearly three thousand millions gallons. Another reservoir of nearly four thousand millions gallons, on the middle branch of the Croton river, has been three years in course of construction, and will be ready for use in January, 1878. As I have several times stated, this reservoir will greatly aid the water supply, but the time, in my opinion, has arrived for commencing a third reservoir, for which a site has been selected on the east branch of the Croton, and plans and surveys are being made in order that this work may be put under contract next season. It must be remembered that we are every year laying additional and larger mains through the city, and the supply at the source must keep pace with the demand in the city. The proposed new reservoir will consume nearly three years in its construction, and will have a capacity of four and a half millions gallons. These three great reservoirs, with the natural lakes for the use of which permanent provision is to be made under the law of last session, added to the natural flow of the Croton, will fill the present aqueduct every day in the year, and secure all the benefit which one aqueduct can possibly afford.

2d.—As there is but one aqueduct or conduit by which water is brought to the city, it is of the first importance that this work should be maintained in thorough repair, so that it may be filled nearly to its roof, and convey its maximum quantity. The Croton aqueduct is a noble structure, and for 35 years has performed its duty without a breach sufficient to interrupt its current. In tunnels or excavations, where it rests upon natural foundations, it continues almost unimpaired; but in crossing valleys, upon artificial foundations, very slight settlements sometimes occur causing cracks and leaks, which can only be temporarily remedied, until the water is drawn off, as is done once a year for as thorough repair as practicable in the short period of three days, beyond which time the supply cannot be intermitted.

Within the past two or three years considerable work has been done towards strengthening the aqueduct in its outer walls, and in improving and perfecting the arch inclosing the water way. It is proposed to continue this work each year, until the aqueduct is rendered as secure as possible, and with this view I have asked the board of estimate and apportionment for a small additional appropriation over and above the ordinary work of maintenance, which I trust will be granted. It is true economy carefully to guard and protect the single conduit by which the city is supplied, as breaches or leaks would entail serious consequences.

3d.—Waste of water must be prevented by the use of meters in all large establishments. Within the past year meters have been placed in railroad and omnibus stables. They have also been applied along the water front on docks and piers, where great waste previously existed. There is yet much to be done in this matter, but it is intended to follow it up until all establishments and places of the kind above-mentioned are metered. This, with careful inspection of private houses by competent persons, will effect an important saving in the amount of water used; indeed, the steps already taken have had an appreciable effect in accomplishing this most desirable purpose.

4th.—For the purpose of ascertaining what supply may be drawn from the Bronx, a careful survey is now in progress, but I am not yet able to state its results. More than fifty years ago, and before it was decided to use the Croton river, examinations were made of the Bronx with the object of supplying the city from its waters.

In 1824 Canvass White, who had been one of the engineers of the Erie Canal, made a survey of this stream, and estimated that by building a dam at the outlet of the Rye ponds in Westchester county, six feet in height, and lowering the outlet two feet, the natural flow of the river could be so far aided as to afford a steady supply of 6,600,000 gallons per day. This quantity was deemed inadequate for a population then comparatively small, but rapidly increasing under the stimulus imparted by the Erie Canal, and its further consideration was abandoned and the study of the Croton valley taken up.

The circumstances are now entirely altered. Then the Bronx river was thought of as the main source of supply; now, if found available at all, it will be merely as an auxiliary, and for the supply of the annexed district north of the Harlem river, to which extent it would relieve the demand upon the present aqueduct, which is every year approaching nearer and nearer the maximum capacity of that structure.

The water should be taken out above White Plains, to avoid the impurities of the numerous villages situated on the Bronx below that place. It could be delivered at some point north of the Harlem river, at an elevation of fifty feet above the present aqueduct, and thus reach the highest ground in the suburban district. The extremely low cost of iron at the present time, as well as other economical considerations, would make an iron pipe of sufficient size the most proper conduit.

The feasibility of this plan will depend upon its cost and the quantity of water which can with certainty be secured. It is very desirable in the present condition of our burdensome debt and taxation, to defer as long as possible the large expense of an additional aqueduct, while at the same time it is equally important to maintain a liberal supply of water for the growing population. Now, if the waters of the Bronx and the Rye ponds can be introduced at a cost commensurate with the quantity delivered, it will just so far aid in securing the object proposed; and this conduit, though comparatively small, will remain a permanent part of the water system of the city. I will present the full results of the survey when the plans and estimates are prepared.

5th.—*The Housatonic River.*—Next to the Croton basin, and as auxiliary thereto, the Housatonic river offers the most interesting an important subject for our consideration.

In my fourth quarterly report of the year 1876, I referred to it as follows:

"I have already explained that the Croton river and basin are adequate for the supply of a city of more than two millions of inhabitants, but in investigating the important subject I have been led to look beyond the Croton basin and to consider what additional supplies may be most feasibly and economically secured for the unfailing and abundant supply of water to this great metropolis.

"My knowledge of the topography of the country immediately north of the Croton valley, obtained from reconnoissances and surveys made several years ago, induced the belief that the waters of the Housatonic river might be tapped and led by conduit to the headwaters of the Croton. A cursory survey, recently made, establishes the perfect feasilibity of this plan at a comparatively moderate cost.

"The Housatonic is a large river, having its source in the Berkshire hills, and in its southerly course through the State of Connecticut approaches, at a point ten miles north of the head of the Croton within a half mile of the New York State line. At this point, known as Bull's Falls, a tributary of the Housatonic breaks through the mountain range which divides New York from Connecticut, and opens a way for the introduction of a canal by which the waters of the Housatonic may be led and discharged into the Croton basin.

"By means of this great auxiliary supply from a large river of the purest quality, the water supply of this great city may be considered assured, even for the distant future. Of course, legislative sanction of the State of Connecticut will be required in perfecting this plan."

In order to obtain accurate information in regard to this project, I propose to have a detailed survey made during the coming season, and plans and estimates prepared and filed in the department, so as to be available whenever the proper time shall arrive for carrying the work into effect.

From the examinations already made, the following information has been obtained:

The watershed of the Housatonic, above Bull's Falls, has an area of about 750 square miles, or more than double that of the Croton. From a measurement of the stream, made at a time of very low water, it was found to discharge about 200,000,000 gallons daily.

A canal of about 27 miles in length will lead the waters of the Housatonic, by gravity, into the Croton basin, for which canal two lines will require examination.

A short canal of ten miles, commencing near Bull's Falls, would, for a time, accomplish the purpose by raising the water at that point by pumps, to be operated by the water power of the river, which here falls 80 feet in half a mile.

With the large supply which the Housatonic will furnish, added to the drainage of the Croton watershed, it is clear that a population of more than three millions will be liberally provided.

6th. *High Service.*—When the Croton water was introduced into New York, and some years subsequently, the city, as then built, was below the level of the receiving reservoir, and water was delivered to the upper stories of the houses by hydraulic pressure. Since that time the elevated portions of the island have been built upon, where the land is as high as the surface of the Park reservoirs. Of course, at those points, the water must be raised to the upper stories by pumping, and this was doubtless the original design of the Croton Aqueduct Commission.

In the year 1870, a small reservoir was built near the southern end of High Bridge, into which Croton water is pumped by steam power, the object being to supply the Manhattanville district. There being a surplus beyond the requirements of that immediate neighborhood, it has been distributed to other high points, and so pressing have been the demands for this high-service water, that it is now extended to the extreme limit of its capacity. Its great value and popularity having been proven, the necessary legislation to authorize the erection of additional pumping power was asked of the last Legislature, but the bill, which passed the Assembly, was not reached in the Senate.

I propose to renew the application at the coming session, and, if granted, to proceed next year with the necessary works upon the city lots between Ninety-seventh and Ninety-eighth streets, near Ninth avenue, already set apart for this purpose, and to carry out this most useful improvement.

[To be continued.]

Prices of Gas Coal.

With the near approach of the close of the year, transactions in domestic coal are becoming light; the requirements of caking coal for the next six months are generally provided for, and but little new business can be expected before March next. New England consumers who are compelled to receive their coal at Baltimore, find the cost enhanced by the advance in water freights, which always takes place at this season, making the cost of Westmoreland and Penn coal about $6.40 in Boston. The same remark applies to shipments from Richmond to New York; these latter freights have advanced from $1.35 the current summer rate, to $1.70 @ $1.75, several vessels having been secured last week at the latter rate. The loss in this case, however, falls upon the coal company and not on the consumer, as the contracts require the seller of the coal to deliver it in New York.

Another fortnight will wind up the shipments of

Provincial coal to the States for the season. Before navigation from that quarter reopens, the question of free coal will have come before Congress, under the proposed modifications of the tariff. Any legitimate steps taken to cheapen the cost of coal to consumers, cannot fail to meet public approval. A bill just presented in the House provides that the culm, or slack coal shall be admitted free, but the sales of this description of coal at any time are extremely limited.

We do not change our quotations for the standard gas coals.

Westmoreland	$5.50	$4.50 } at Baltimore.
Penn	5.50	4.50 }
Despard	5.35	
Marion	5.35	
Murphy Run	5.35	
Newburgh Orrel	5.35	
Ches. and Ohio RR. Caking Coal	5.40	$4.10 f. o. b. at Richmond.
Block House	4.50	1.75 } Gold f. o. b. at Mines
Glace Bay	4.25	1 60 }
International	4.25	1.60 }
Clover Hill	4 00	
Cannelton Cannel	10 00	
Peytona	10.00	

Gas Stocks.

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24 Pine Street, New York City.

December 17, 1877.

☞ All communications will receive particular attention

Gas. Co.'s of N. Y. City.

	Capital.	*Par.*	*Bid.*	*Asked.*
Central, Westchester	466,000	50	90	95
Harlem	$1,850,000	50	97	100
Manhattan	4,000,000	50	210	215
Metropolitan	2,500,000	100	132	—
" Scrip	$1,000,000	..	100	103
" Bonds	500,000	1000	92½	95
Mutual	5,000,000	100	90	95
" Bonds, gold.	900,000	1000	105	—
Municipal	1,000,000	100	90	—
New York	4,000,000	100	—	120
Suburban, W'steh'str	390,000	50	—	100
Gas Co.'s of Brooklyn.				
Brooklyn	2,000,000	25	170	175
Citizens	1,200,000	20	75	80
" Scrip	320,000	1000	95	97½
Peoples	2,000,000	10	—	40
" Bonds	$ 325,000	...	—	95
" Scrip	300,000	...	75	80
Metropolitan	1,000,000	100	65	70
Nassau	1,000,000	25	—	78
" Ctfs.	700,000	1000	96	98
Williamsburgh	1,000,000	50	120	125
" Scrip		...	100	103
Union Co. E. N. Y.		25	—	50
Richmond Co., S. I.	300,000	...	80	90
Out of Town Gas Companies.				
Bath, Maine	70,000	100		
Buffalo Mutual, N. Y	750,000	100	65	70
" Bonds	200,000	1000	95	100
Baltimore, Md.	2,000,000	100	134	134
" Ctfs., gold	1,000,000		106	110
Bayonne, N. J.		100		90
Brockport, N. Y.	25,000	100	...	80
Citizens, Newark	918,000	50	100	105
" " Bds.	124,000	—	—	—
Cincinnati G & C Co				190
Derby of Conn.	160,000	100	60	80
East Boston, Mass.		25	132	—
Fort Wayne, Ind.		100	...	—
Hannibal, Mo.	100,000	100	95	100
Hartford, Conn.	700,000	25	184	186
Hempstead, L. I.	25,000	100	...	—
Jersey City	386,000	20	155	165
Jamaica, L. I.	25,000	100	...	—
Jacksonville, Ill.	120,000	50	82	...
Lewistown Maine	400,000	100	50	85
Lima, Ohio,	60,000	100	—	...
Bonds	30,000		90	
Laclede, St Louis Mo.	1,200,000	100	100	110
Long Branch		20	40	50
Peoples, Jersey City		...	120	125
Peoples of Albany	650,000	100	-	27
" Bonds	350,000	1000	--	-
Peoples of Baltimore		25	--	56
" Bonds			106	---
Perth Amboy		25	—	95
Rochester, N. Y.		100	50	60
Woonsocket, R. I.	150,000	100	100	...
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
San Francisco Gas Co., S. Fr'isco Cal.			111	112
St. Louis, Missouri	600,000	50	73	75
Stillwater, Minn.	50,000	50	—	26
Saugerties, N. Y.	15,000	100	95	100
Troy, Citizens.	600,000	100	—	60
Toledo, Ohio			95	97

100 shares New York gas, sold at auction, @ 120 to 121; 47 shares of Citizens, of Brooklyn, @ 85; 54 shares Manhattan, @ 210 to 210½.

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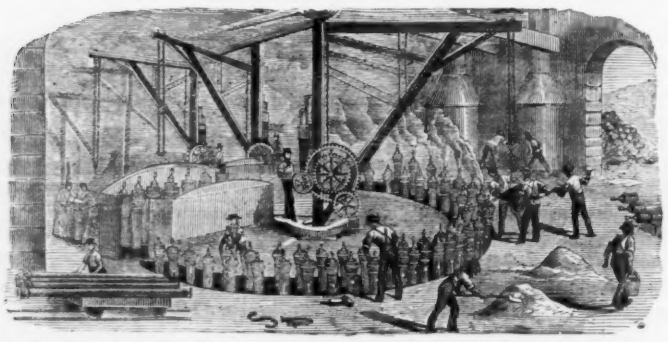

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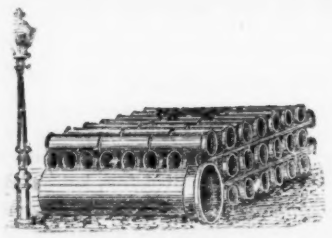

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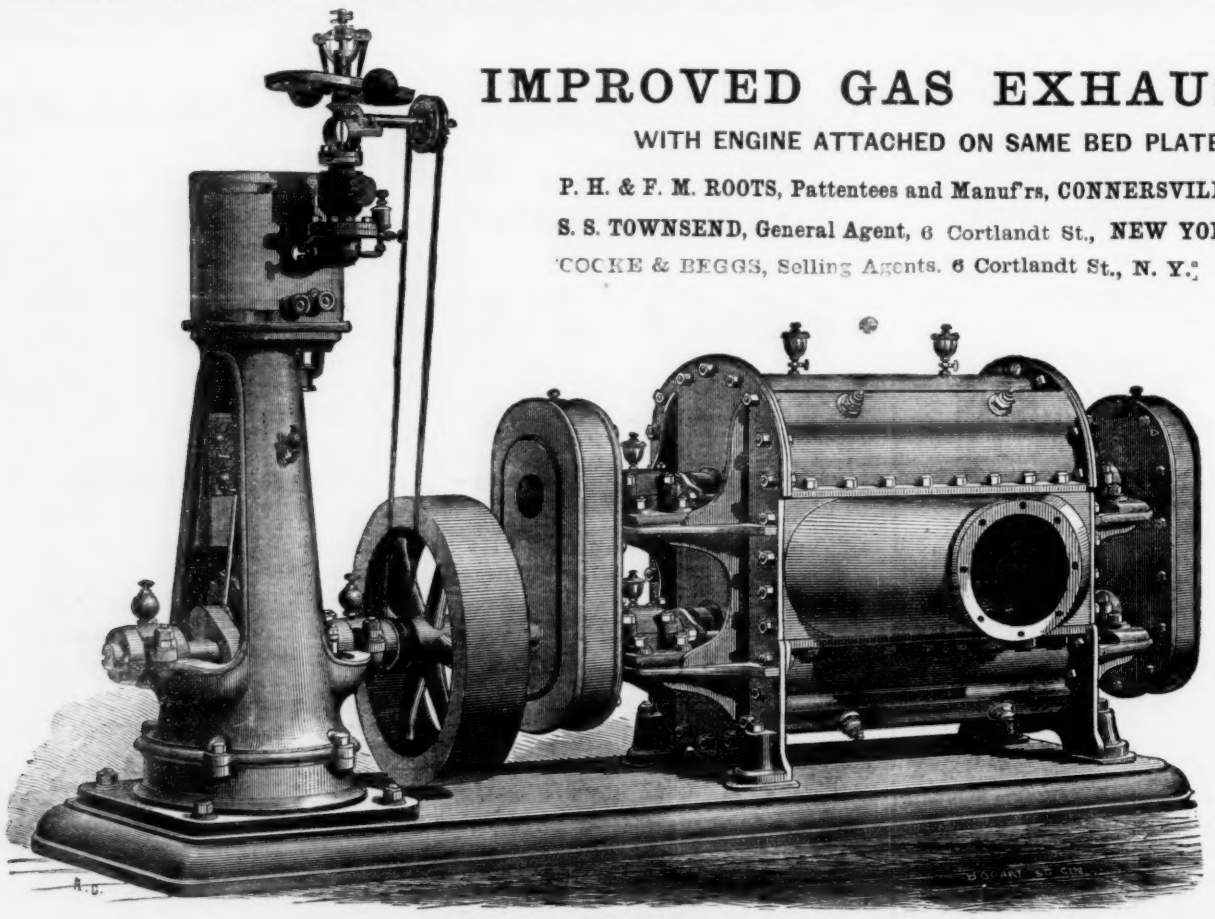

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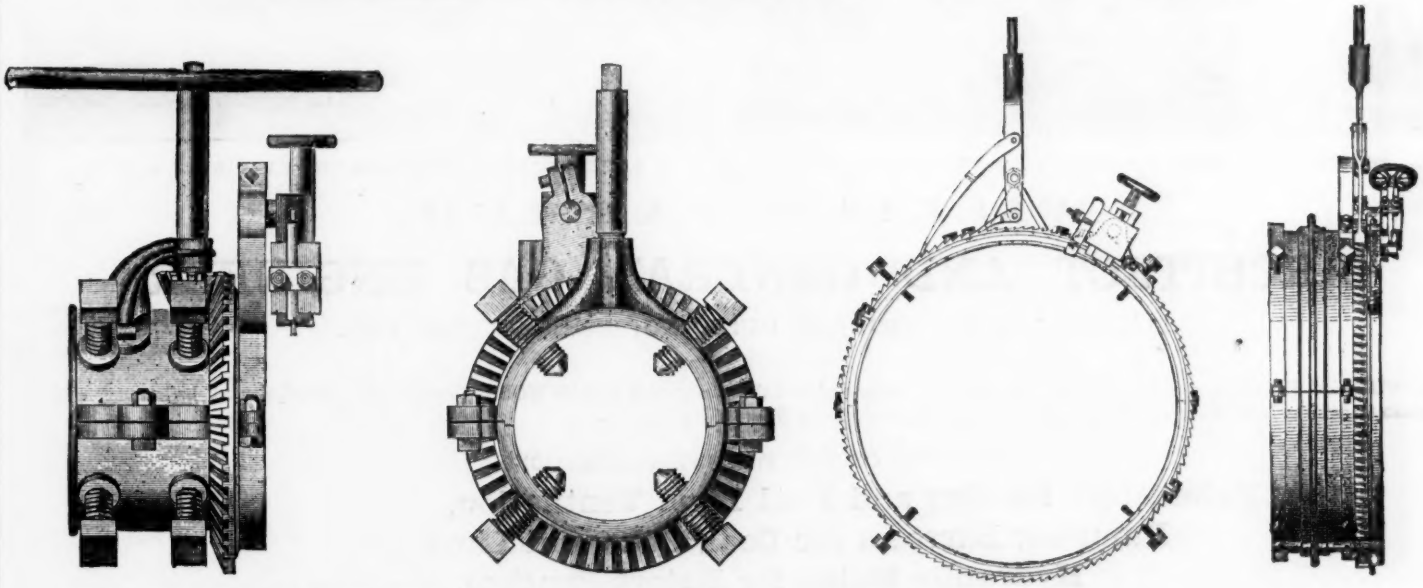

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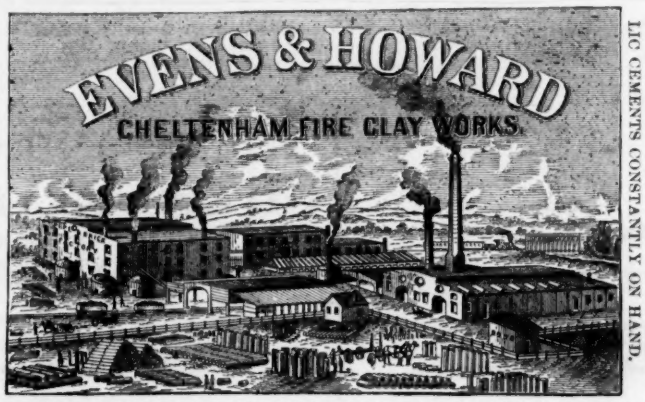

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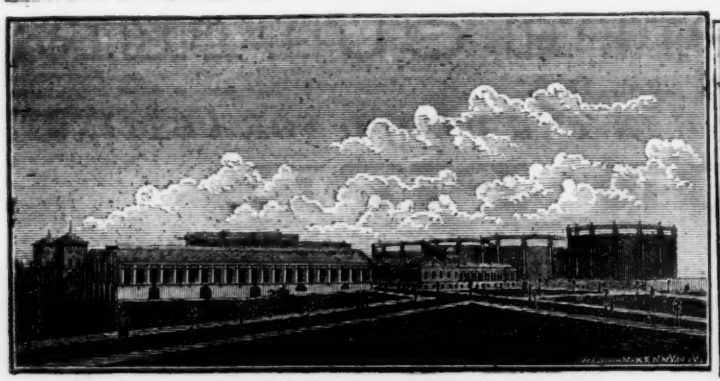

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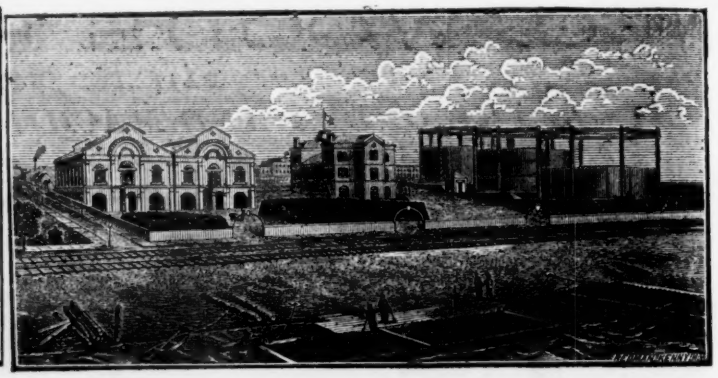

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The process known as GWYNNE-HARRIS, but from later most essential improvements, more appropriately called the ALLEN-HARRIS, or AMERICAN HYDROCARBON process for making "Water Gas," by the decomposition of superheated steam, in fire-clay retorts, set similarly to those in Coal Gas Works, is an established success. More than One Hundred Million cubic feet of gas have been made under this process, and for *permanency* and *brilliancy*, as well as economy both to the manufacturer and consumer, it is superior to any gas made by the old, or any other method.

The Citizens Gas Company of Poughkeepsie, New York, have, since June 1st, 1875, made their gas *solely under this process*. They light all of the street lamps and municipal buildings, as well as the greater portion of the city, and if the truth is the object of inquiry, let their Works and their consumers be examined.

Our process is *not intermittent* but continuous. The steam and the oil are admitted into the retorts by gauge cocks, and run for days without change. All the materials required, besides the steam, are 17 lbs. of Anthracite coal and about 3½ gallons of Petroleum or Naphtha, per 1000 feet of brilliant gas.

Rigths for sale. Inquire of the President.

BROWN & OWEN,

MANUFACTURERS OF

EVERY DESCRIPTION OF

Gas and Water Works Supplies.

Particular attention given to the alterations of old works

Estimates and Drawings furnished.

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Oregon Iron Foundry

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MANUFACTURERS OF

ALL KINDS OF CASTINGS

AND

APPARATUS FOR GAS-WORKS.

BENCH CASTINGS
from benches of one to six Retorts each.

WASHERS: MULTITUBLAR AND AIR CONDENSERS: CONDENSERS; SCRUBBERS,

wet and dry), and

EXHAUSTERS
for relieving Retorts from pressure.

BENDS and BRANCHES
of all sizes and description.

FLOYD'S PATENT
MALLEABLE RETORT LID.

SABBATON'S PATENT
FURNACE DOOR AND FRAME.

SELLER'S CEMENT
for stopping leaks in Retorts.

GAS GOVERNORS,
and everything connected with well regulated Gas Works, at low price, and in complete order.

N. B.—**STOP VALVES** from three to thirty inches—very low prices.

SILAS C. HERRING. JAMES R. FLOYD.

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LAUREL IRON WORKS.

ADDRESS, 39 LAUREL STREET,

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MANUFACTURERS OF

GAS HOLDERS,

SINGLE AND TELESCOPIC—WITH CAST OR WROUGHT IRON GUIDE FRAMES.

We are prepared to furnish Holders, Wrought Iron Roof Frames, Bench Castings, Condensers, Scrubbers. Purifiers, Drips, Bends, Tees, and all other Iron Work connected with Gas Works. Previous to 1868 our Mr. D. built *nine Gas Works* and *fifty-four Holders*. Since that date we have built *three Gas Works* and *forty-six Holders*. We *superintend in person* the erection of all our work, and would refer to the Gas Companies at the following places, where we have built Holders, since 1868:

Lancaster, Pa.
Williamsport, Pa.
Bristol, Pa.
Catasaqua, Pa.
Kittanning, Pa.
Hazelton, Pa.
Freeport, Pa.
Huntingdon, Pa.
Pittston, Pa.
Bethlehem S). Pa.
Sharon, Pa.
Canton, Pa.
Annapolis, Md.
Parkersburg, Wes,
Lynchburg, Va.
Youngstown, O
Steubenville, O.
Zanesville, O.
Mansfield, O.
Marion, O.
Bellcaire, O.
Athens, O.
Barnesville, O.
Franklin, Ind
Jacksonville, Ill. (2)
Joliet, Ill.
Lawrence, Kansas.
Jefferson City, N. O., La.
Algiers, N. O., La.
Kalamazoo, Mich.
Buffalo, N. Y.
Ogdensburg, N. Y.
Waverly, N. Y.
Little Falls, N. Y.
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Watkins, N. Y.
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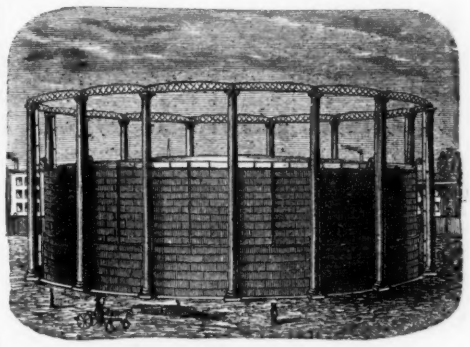

GAS-HOLDERS

OF ANY MAGNITUDE,

Condensers, Scrubbers, Purifiers, Retorts, Hydraulic Mains, and all other articles connected with the Manufacture and Distribution of Gas, furnished with despatch. Plans and Specifications prepared, and Proposals given for the necessary Plans for Lighting Cities, Towns, Mansions, and Manufactories.

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Camden Iron Works

Camden, New Jersey,

Office in Philadelphia No. 435 Chestnut St., where a member of the Firm can be seen between 12 m. and 2 p. m. daily.

MANUFACTURERS OF

ALL KINDS OF CASTINGS AND APPARATUS FOR GAS WORKS,

Wrought Iron Roof Frames,

For Retort and other houses. Retorts and all castings required for setting them in the latest and most improved model. WASHERS, CONDENSERS, SCRUBBERS and EXHAUSTERS for relieving the Retorts from pressure. PURIFIERS, varying from 2,000 to 2,000,000 cubic feet daily purifying capacity.

Wrought Iron Lime Sieves

for Purifiers. Station Meters of all sizes.

GAS HOLDERS,

TELESCOPIC AND SINGLE

With cast iron guide and suspension frames. GAS GOVERNORS or REGULATORS, STREET MAINS, from 1½ to 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

STOP VALVES, from 3 to 30 inches, for both Water and Gas.

Wrought Iron Work.

All the Smith and Sheet Iron work required in and about Gas Works. 226-tf

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GEO. STACEY & CO.

MANUFACTURERS OF SINGLE AND TELESCOPIC

GAS-HOLDERS,

AND ALL KINDS OF

Cast and Wrought Iron Work

Used in the Erection of Gas and Coal Oil Works.

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Gas Works, Smelting Works & Machinery.

Proprietors of P. W. MACKENZIES PROCESS AND APPARATUS for making Illuminating Gas from Ordinary Gas Coals, enriched with Cannel or Oil. Also, Mackenzies Process for Making Heating Gas for Smelting, Melting, Puddling, Forges, Boilers, Etc. Also,

P. W. Mackenzie's New Engine and Boiler.

434-1y

INTERNATIONAL--1876--EXHIBITION.

The U. S. Centennial Commission

HAVE DECREED AN AWARD TO

HARRIS, GRIFFIN & CO.,

12th and Brown Sts., Philadelphia, and 49 Dey St., N. Y., U. S, A.,

FOR THE FOLLOWING REASONS:

The Exhibit consists of a Series of METERS from the Largest Size Station Meters for the use of the MANUFACTURE OF GAS, to those for the use of the ORDINARY CONSUMER. The Instruments are WELL MADE, RELIABLE as to INDICATION, and embody a number of sundry improvements which, with the general character of the Exhibit, entitle the whole to commendation.

Attest—J. L. CAMPBELL, Secretary, pro-tem.

Signed—A. T. GOSHORN, Director General

J. R. HAWLEY, President

GROUP JUDGES.

AMERICAN.

PROF. JOSEPH HENRY, LL.D., Secretary of Smithsonian Institution, Washington, D. C.
PROF. F. A. P. BARNARD, S.T.D., LL.D., President of Columbia College, N. Y.
PROF. J. E. HILGARD, Washington, D. C.
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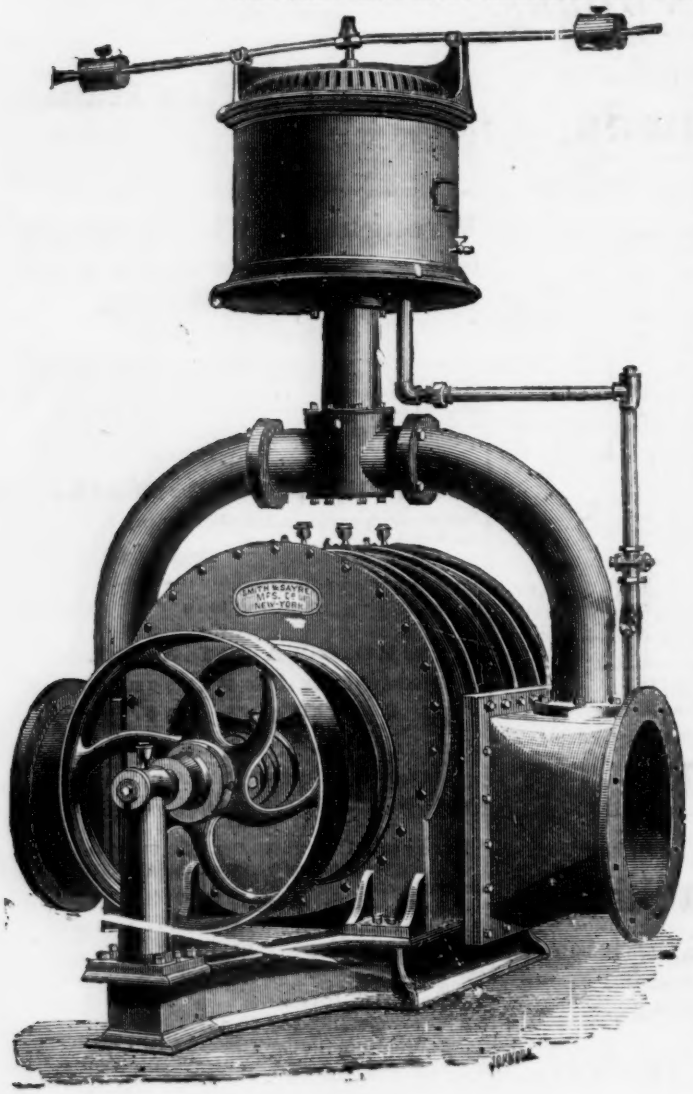
SMITH & SAYRE MANUFACTURING COMPANY.
21 Cortlandt Street, New York,
PROPRIETORS AND MANUFACTURERS OF

Mackenzie's Patent Gas Exhausters.

THE BEST AND MOST RELIABLE IN USE.



ISBELL'S BALANCE VALVE COMPENSATOR, and AUTOMATIC BYE-PASS are used in connection with this Exhauster, as shown in above cut.
MACKENZIE'S PATENT STEAM JET EXHAUSTER and SURFACE CONDENSER, with AUTOMATIC WATER REGULATOR.
ISBELL'S DOUBLE GATE STOP VALVES for Water and Gas.
ISBELL'S AUTOMATIC GOVERNOR for regulating Pressure of Gas in Street Mains.
Patent DEODORIZING APPARATUS for Foul Lime of Purifying Boxes.
Engines, Boilers, Tees and Bends and GAS APPARATUS of every description.
Send for descriptive pamphlet. We refer to all the Gas-Light Companies of the United States.
G. G. FOETER, President.
CHARLES W. ISBELL, Secretary. Office, Coal and Iron Exchange Building, Cortlandt cor. New Church Sts.

THE PERFECT GAS HEATER

Constructed on the superheating principle, producing perfect combustion.

Saves 33 1-2 per cent. over any other Stove.

No Coal or Wood to handle.
No Dirt.
No Dust.

Thorough radiation.

It *can* be connected with a chimney, or run through a small board placed under the window.

JUST THE THING FOR

Dining, Sitting or Bath Rooms, Parlors, Offices, Studies, and Conservatories

Send for Circular.

THE RETORT GAS STOVE CO.,
189 Eddy Street, Providence, R. I.

SITUATION WANTED,

BY A PRACTICAL MAN, AS SUPERINTENDENT IN A GAS WORKS.

(Southern States preferred). Refers by permission to the officers of the Company engaged with for the past eleven years. Address "GAS SUPERINTENDENT," office of this Journal. 441—6t

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As Foreman of a Gas Works

Is desirous of making a change. Is well known by several Gas-Light Companies.

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AMERICAN METER COMPANY,

MANUFACTURERS OF

Wet and Dry Gas Meters (with Slide or Rotary Valves), Station Meters, Dry Centre Valves, Pressure Registers, Pressure and Vacuum Registers, Meter Provers, King's Pressure and Vacuum Gauges, Exhauster Governors, Experimental Meters, Watchman's Clocks, Etc., Etc.

☞ Sole Agents for W. Sugg's **PHOTOMETRICAL** and **ANALYTICAL GAS APPARATUS.**

A full assortment of the above kept at the Manufactories and Agencies, where orders may be addressed,

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HARRIS, HELME & McILHENNY,

Successors to Harris & Brother.

ESTABLISHED 1848.

PRACTICAL GAS METER MANUFACTURERS,

Continue as heretofore at the OLD ESTABLISHMENT, Nos. 1115 and 1117 Cherry Street, Philadelphia, Pa.,

To manufacture Wet and Dry Gas Meters, Station Meters, Experimental Meters, Meter Provers, Centre Seals, Governors, Pressure Registers, Indicators, Photometers, and all kinds of Gas Apparatus; Also furnish all other Articles appertaining to the use of Gas Works.

From our long Practical Experience of the Business (covering a period of 28 years) and from our personal supervision of all Work, we can guarantee all orders to be executed promptly, and in every respect satisfactorily.

WASHINGTON HARRIS. WILLIAM HELME. JOHN McILHENNY.

WILLIAM W. GOODWIN & CO.

No. 1012, 1014 and 1016 Filbert Street,

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MANUFACTURERS OF

Dry and Wet GAS METERS, Station Meters (Square, Cylindrical or in Staves) Glazed Meters, King's and Sugg's Experimental Meters Lamp Post Meters, Etc., Etc., Meter Provers (sizes 2, 5 and 10 feet), Pressure Guages of all kinds, Pressure Registers, Pressure and Vacuum Gauges, Pressure Indicators (sizes 4 inch, 6 inch and 9 inch), King's Pressure and Vacuum Gauges, Dry and Wet Centre Seals, Dry and Wet Governors, Exhauster Governors, Photometers of all descriptions. Letheby's Sulphur and Ammonia Test Apparatus complete—also Testing and Chemical Apparatus of all kinds, and of the most perfect description, for all purposes relating to Gas.

Goodwin's Improved Lowe's Jet Photometer.

W. W. Goodwin is the author of the History and Principles involved in the use of Lowe's Jet Photometer. Also Patentee and we are the SOLE MANUFACTURERS of the ORIGINAL and ONLY DIAL whereby the CANDLE POWER and PRESSURE can be instantly read, and all others are infringements.

Special attention to repairs of Meters, and all apparatus connected with the business.

All work guaranteed first class in every particular, and orders filled promptly.

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MAKE your own GAS

GAS GENERATORS, FOR LIGHTING Dwelling-Houses, Public Buildings, Churches, Factories, etc., etc.

Send for CIRCULAR.

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SPRINGFIELD GAS MACHINE 238 CANAL ST. NEW YORK

KIDD'S

Gas Consumers Guide

Enables every Gas Consumer to ascertain at a glance, without any previous knowledge of the Gas Meter, the quantity and money value of the Gas consumed. Also the best method of obtaining from Gas the largest amount of its light.

It will be to the advantage of Gas Companies to supply their Consumers with one of these Guides, as a means of preventing complaints arising from their want of knowledge in regard to the registration of their meters. For sale by

A. M. CALLENDER & CO.,
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Portland Cement,
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Keene's White Cement,
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4 Cents per lb.

English Fire Brick, No. 1, $28 per M.
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FODELL'S

System of Bookkeeping

FOR GAS COMPANIES.

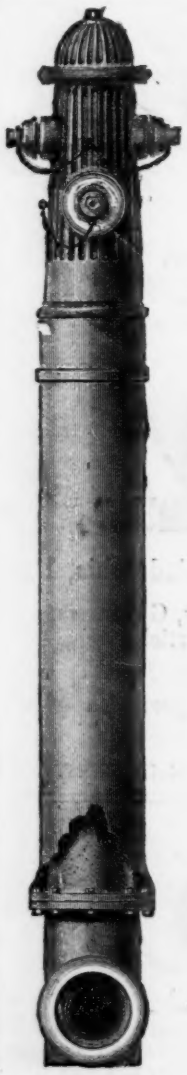
Price $5, which should be sent either in Check, P. O. Order or Registered Letter.

Blank Books, with printed headings and forms on this system, will be supplied to Gas Companies, by applying to W. F. FODELL Philadelphia, or

A. M. CALLENDER & CO.,
Office GAS-LIGHT JOURNAL, 42 Pine St, N.Y

EXTENSION OF WATER MAINS AT CEDAR RAPIDS, IOWA.—The extension of the water main across the river at Cedar Rapids, Iowa, has been completed. Some delay was met with in the shape of an injunction by Major May, preventing their crossing one of his lots, but a purse of seventy-five dollars modified his grievance, and the work proceeded.—*Ibid.*

WATER FOR SAN FRANCISCO.—The Board of Water Commissioners of San Francisco on October 18, formally accepted the proposition of the Blue Lakes Water Company to bring water to the city for $13,500,000. As soon as the necessary preliminaries are accomplished the question will be submitted to the people.—*Ibid.*



CHAPMAN VALVE MFG. CO.

MANUFACTURERS OF

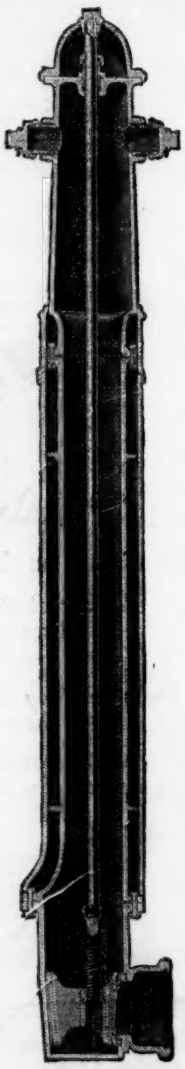
WATER, GAS AND STEAM

VALVES

AND

FIRE HYDRANTS,

With BABBITT METAL SEATS.



CHAPMAN GAS VALVES

Have been in use since 1869, and are pronounced by all who have used them to be

SUPERIOR TO ALL OTHERS FOR GAS PURPOSES.

They afford a direct passage the full size of the pipe. The seats are made of an alloy similar to BABBITT metal, specially prepared for the purpose, and superior to all other metals used for the seats of Gas Valves, as it does not corrode.

There is NO LIABILITY OF COHESION between the Gate and Seat, and the Valves can be relied upon to SHUT TIGHTLY and OPEN EASILY at all times—an important desideratum when used for street mains, in cases of fire.

ALL VALVES GUARANTEED.

We refer to the following named Gas-Light Companies among the many that have used these Valves:

Boston Gas-Light Company,	Mass.
South Boston Gas-Light Company,	"
East Boston Gas-Light Company,	"
Charlestown Gas-Light Company,	"
Cambridge Gas-Light Company,	"
Brookline Gas-Light Company,	"
Jamaica Plain Gas-Light Company,	"
Newton & Watertown Gas-Light Co.,	"
Waltham Gas-Light Company,	"
Chelsea Gas-Light Company,	"
Fitchburg Gas-Light Company,	"
Marlboro' Gas-Light Company,	"
Clinton Gas-Light Company,	"
Milford Gas-Light Company,	"
Attleboro' Gas-Light Company,	"
Lawrence Gas-Light Company,	"
Lowell Gas-Light Company,	"
Lynn Gas-Light Company,	"
Springfield Gas-Light Company,	"
Worcester Gas-Light Company,	Mass.
Taunton Gas-Light Company,	"
New Bedford Gas-Light Company,	"
North Bridgewater Gas-Light Company,	"
Plymouth Gas-Light Company,	"
Middleboro' Gas-Light Company,	"
Marblehead Gas-Light Company,	"
Leominster Gas-Light Company,	"
Malden & Melrose Gas-Light Company,	"
Quincy Gas-Light Company,	"
Woburn Gas-Light Company,	"
Providence Gas-Light Company,	R. I.
Pawtucket Gas-Light Company,	"
Newport Gas-Light Company,	"
New Haven Gas-Light Company,	Conn.
Portland Gas-Light Company,	Maine.
Lewiston Gas-Light Company,	"
Calais Gas-Light Company,	"
Rockland Gas-Light Company,	"
Manchester Gas-Light Company,	N. H.
Concord Gas-Light Company,	"
Nashua Gas-Light Company,	"
Exeter Gas-Light Company,	"
Dover Gas-Light Company,	"
Portsmouth Gas-Light Company,	"
Great Falls Gas-Light Company,	N. H.
St. Albans Gas-Light Company,	Vt.
Louisville Gas-Light Company,	Louisville, Ky.
Cincinnati Gas-Light Company,	Cincinnati, O.
People's Gas-Light Company,	Brooklyn, N.Y.
Citizen's Gas-Light Company,	" "
Williamsburg Gas-Light Co.	" "
Brooklyn Gas-Light Company,	"
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